United States Court of Appeals

for the Second Circuit

EXHIBITS

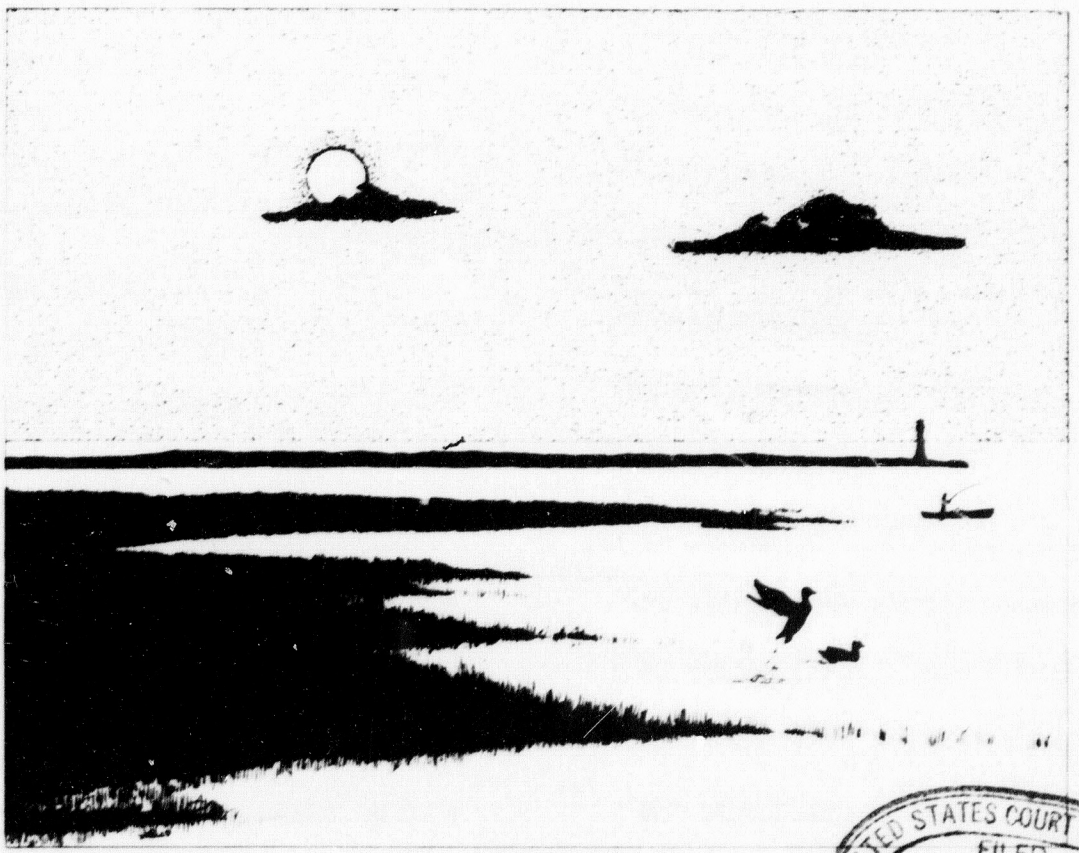
UNITED STATES
DEPARTMENT OF THE INTERIOR

FINAL ENVIRONMENTAL STATEMENT

76-6122

B

Volume 1 of 4



UNITED STATES COURT OF APPEALS
FILED
SEP 14 1976
A. DANIEL FUSARO, CLERK
SECOND CIRCUIT

Proposed
1976 OUTER CONTINENTAL SHELF
OIL AND GAS LEASE SALE
OFFSHORE THE MID-ATLANTIC STATES

OCS SALE No. 40

Prepared by the
BUREAU OF LAND MANAGEMENT

Curt Berklund

Director

Summary

( ) Draft (X) Final Environmental Statement

Department of the Interior, Bureau of Land Management
New York OCS Office, New York, New York 10048

1. Proposed Oil and Gas Lease Sale, Outer Continental Shelf Mid-Atlantic

(X) Administrative ( ) Legislative Action

2. One hundred fifty four tracts (876,750 acres) of OCS lands are proposed for leasing action. The tracts are located offshore of New Jersey and Delaware with distance to shore ranging from 47 to 92 miles. The tracts are situated in water depths that range from approximately 40 meters to 185 meters. If implemented, this sale is tentatively scheduled to be held in the summer of 1976.

3. All tracts offered pose some degree of pollution risk to the environment. The risk potential is related to adverse effects on the environment and other resource uses which may result principally from accidental or chronic oil spillage. Socio-economic effects from onshore development will have small impact on a state or regional basis, but may cause local problems.

Several mitigating measures will be applied which will reduce the type, occurrence, and extent of adverse impacts associated with this proposal. Other measures, which are beyond the capability of this agency to apply, have been identified. In spite of mitigating measures, some impacts must be considered unavoidable. For instance, oil spills are considered statistically probable, some disturbance to fishery and wildlife values will occur, and some onshore development may take place in relatively undeveloped areas. Each tract offered has received a proximity evaluation using a matrix technique to identify significant environmental impacts should leasing and subsequent oil and gas exploration and development ensue.

4. Alternatives considered:

A. Hold the Sale in Modified Form
   1. Delete tracts
   2. Substitute tracts

B. Delay the Sale
   1. Pending Implementation of CZM Plans
   2. Pending Completion of Studies Concerning the Environmental Impacts of Offshore Mineral Development
   3. Pending Development of New Equipment to Provide Increased Environmental Protection

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C. Withdraw the Sale
   1. Energy Conservation
   2. Conventional Oil and Gas Supplies
   3. Coal
   4. Nuclear Power
   5. Oil Shale
   6. Hydroelectric Power
   7. Solar Energy
   8. Energy Imports
   9. Geothermal Energy
   10. Other Energy Sources
   11. Combination of Alternatives

D. Alternative Leasing Areas

E. Alternatives Within the Proposed Action
   1. Government Exploratory Drilling Before Leasing
   2. State Participation in Development Decision

5. Comments have been requested from the following:

* Department of Commerce
  Department of Defense
  * Army Corps of Engineers
  Department of Transportation
  * U.S. Coast Guard
  * Materials Transportation Bureau
* Energy Research and Development Administration
* Nuclear Regulatory Commission
* Federal Energy Administration
* Environmental Protection Agency
* National Aeronautics and Space Administration
  Advisory Council on Historic Preservation
  Department of the Interior
  * U.S. Geological Survey
  * U.S. Fish and Wildlife Service
  * Bureau of Mines
  * National Park Service
  * Bureau of Outdoor Recreation
  State of New York
  * Department of Law
  * Department of Environmental Conservation
* State of New Jersey
* State of Delaware
* State of Maryland
* Commonwealth of Virginia

6. Draft environmental statement made available to Council on Environmental Quality and the public on December 10, 1975.

7. Final environmental statement made available to Council on Environmental Quality and the public on May 25 , 1976.

* Comments Received

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I. DESCRIPTION OF THE PROPOSAL

A. Proposed Federal Action

The proposed Federal action under consideration is the leasing of 154 tracts on the Mid-Atlantic Outer Continental Shelf (OCS), in an area known as the Baltimore Canyon Trough (Figure I-I). These tracts comprise an area of 876,750 acres. They are being proposed to be leased for the exploration, development, and production of potential oil and gas resources in accordance with Section 8 of the Outer Continental Shelf (OCS) Lands Act (76 Stat. 462; 43 U.S.C.; Sec. 1337) and regulations issued under that statute.

The proposed action would constitute a first sale in a frontier area, and would not represent development of the entire Baltimore Canyon area. To develop the estimated recoverable resources of the Baltimore Canyon area, further sales would be required.

1. Location and Resources

The sale under consideration includes tracts offshore New Jersey and Delaware. The tracts in this proposed sale range from 40 meters to 185 meters (131 to 607 feet) in water depth and from 47 to 92 miles from shore (Visual 1). No tracts include areas in water depths greater than 200 meters.[1]

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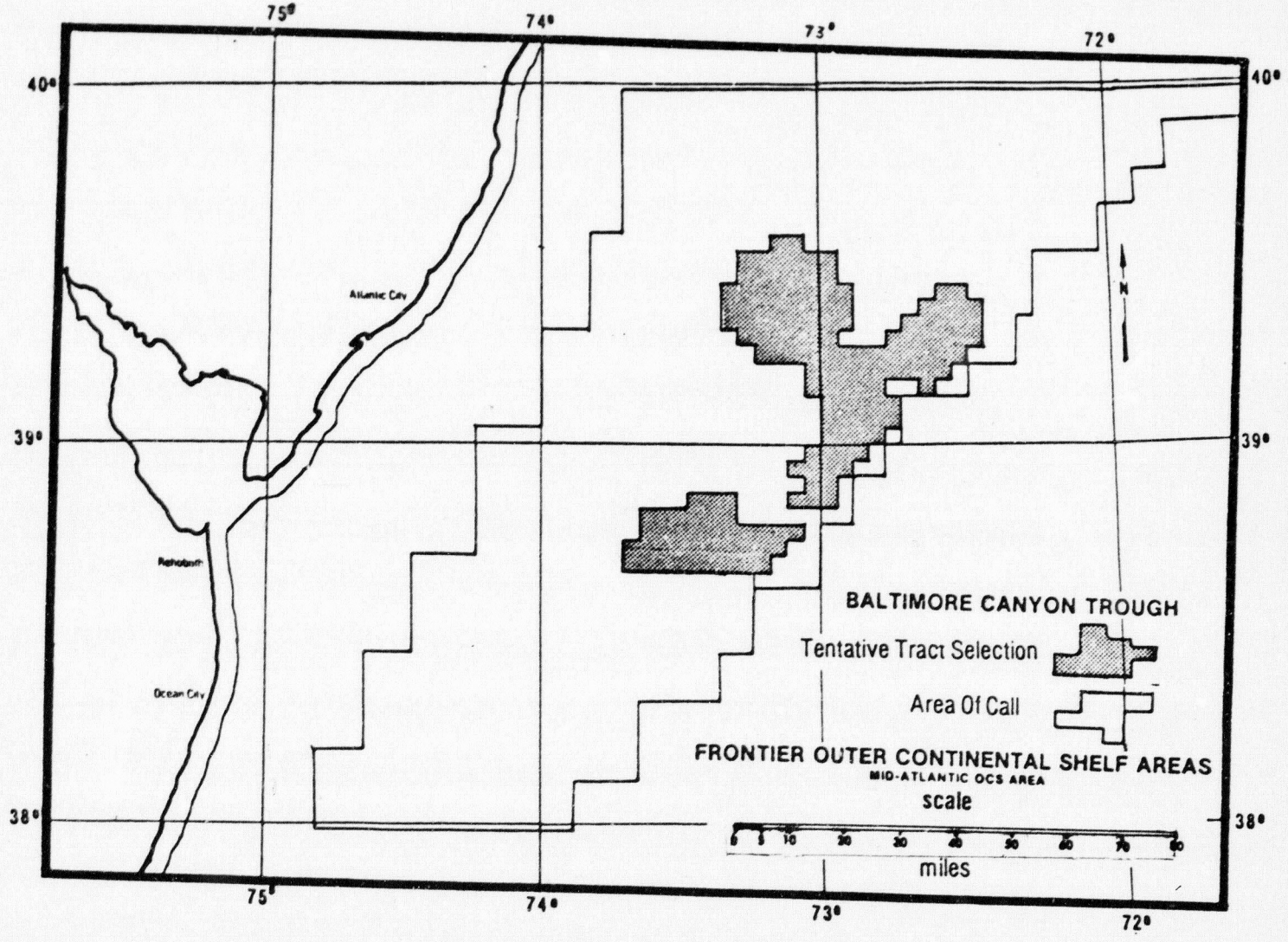
[1]The tracts are summarized by water depth and distance from shore in the first two columns of Appendix 10.

Figure I-1.


75°
74°
73°
72°
40°
39°
38°
Atlantic City
Rehoboth
Ocean City
N
BALTIMORE CANYON TROUGH
Tentative Tract Selection
Area Of Call
FRONTIER OUTER CONTINENTAL SHELF AREAS
MID-ATLANTIC OCS AREA
scale
miles

The U.S. Geological Survey (USGS) estimated in September, 1975, based on proprietary geophysical data, that the undiscovered recoverable resources of the 154 tracts included in the proposed lease sale area range from 0.4 to 1.4 billion barrels of oil and 2.6 to 9.4 trillion cubic feet of gas.

Based on the Geological Survey's estimates of the potential undiscovered resources of the 154 tracts (876,750 acres) proposed for sale, the peak production could range from 90 to 320 thousand barrels of oil and from 0.85 to 3 billion cubic feet of gas per day, peaking approximately 10 years after production has commenced.[1]

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[1]An initial estimate that was provided by the USGS to the Bureau of Land Management New York OCS Office in January 1975, prior to tract selection, was that a proposed Baltimore Canyon sale might result in the leasing of an area containing 2.6 billion barrels of oil and 12.8 trillion cubic feet of gas. Based on this estimated peak daily production would be 740,000 barrels of oil and 4.4 billion cubic feet of gas. Because this proposal is located in a frontier area in which no exploratory wells have been drilled, there is no assurance that petroleum in commercial quantities exists and all estimates are speculative. Therefore in order not to underestimate any potential adverse effects, this initial estimate has been maintained and used as a high discovery case for some of the analytical work for impact anaylsis.

B. Legal and Administrative Background

In 1953, the Outer Continental Shelf Lands Act (67 Stat. 462) established Federal jurisdiction over the submerged lands of the Continental Shelf seaward of the state boundaries (usually the three-mile limit of the territorial seas). Federal jurisdiction of the OCS beyond the three-mile limit on the Atlantic coast was upheld in March 1975, in the Supreme Court decision U.S. vs. Maine, 420 U.S. 515 (43 L.ED.2nd 363). The OCS Lands Act charged the Secretary of the Interior with the responsibility for administration of mineral exploration and development on the OCS. It also empowered the Secretary to formulate regulations so that provisions of the Act might be met.

Subsequent to the passage of the OCS Lands Act of 1953, the Secretary of the Interior designated the Bureau of Land Management (BLM) as the administrative agency for leasing submerged Federal lands, and the Geological Survey for supervising operations. The Department formulated three major goals for the comprehensive management program of marine minerals. These are:

(1) The orderly development of marine mineral resources to meet the energy demands of the nation.

(2) The protection of the marine and coastal environment.

(3) The receipt of a fair return for the leased mineral resources.

These leasing objectives are based on legislative mandates as explained below.

(1) Orderly resource development is based on the OCS Lands Act which gives the Secretary the authority, in order to meet the demand for oil and gas, to grant leases to the highest qualified bidder(s) on the basis of sealed competitive bids.

(2) The policy of protection of the marine and coastal environment is a direct outgrowth of the National Environmental Policy Act of 1969. This Act requires that all Federal agencies shall utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences in any planning and decision-making which may have an impact upon the environment. Responses to these requirements by BLM include the formation of Environmental Assessment Teams, development of Environmental Impact Statements (EIS's), and sponsorship of contract studies. These studies include environmental studies, baseline, and special studies designed to provide information for assessing the effects of oil and gas operations.

(3) Receipt of fair market value has its basis in two separate mandates. United States Code 31, Sec. 483(a) obligates the Federal Government to obtain a fair market return for public lands that are sold or leased. This is further implemented within the Executive Branch by Bureau of the Budget Circular A-25.

C. Tract Selection Process

The tract selection process is one of the steps used by the Department to achieve its objective of orderly resource development, environmental protection, and receipt of fair market value.

1. Procedure and Nominations

As a first step, the Department identified a broad, potential lease area in the Baltimore Canyon Trough--the area opened to nominations. In this case, the area consisted of about 6.5 million acres, located approximately between 38° and 40° north latitudes (roughly between points off Toms River, New Jersey, and the Maryland-Virginia state line, beginning 23.5 to 50 miles offshore). Resource reports on the area under consideration were requested from other Federal agencies in December 1974. In March 1975, a Call for Nominations was issued.[1] The Call invited industry to nominate tracts[2] within the broad area which they would like to see offered for lease. Interested parties or persons, including State governments, were also invited in the Call to indicate tracts or areas which they felt should be withheld from leasing for environmental or other reasons.

The Call for Nominations for this Mid-Atlantic proposal resulted in approximately 3.2 million acres (557 tracts) being nominated by twenty

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[1] See Appendix 1.

[2] Each tract is approximately nine square miles in area, consisting of 5,693.18 acres (2,304 hectares).

companies from the 6.5 million acres delineated (see Figure I-2). Interest shown, as determined by the number of nominations per tract, was an important factor in the tract selection process.

The nominations and comments were evaluated by the Bureau of Land Management. Specific considerations and criteria for evaluations will be discussed in the succeeding section. The BLM New York OCS Office compiled and evaluated all information available to it, including geologic and other environmental data, socio-economic information, and resource reports of other Federal agencies. The New York OCS Office also prepared a written report and maps overlays.

During the period of the Call for Nominations, the Eastern Region Conservation Division of the U.S. Geological Survey analyzed all of the geological and geophysical data available to it, including a substantial amount of proprietary geophysical data, to prepare its own list of initial field level tract preferences.

The Northeast Regional Office of the U.S. Fish and Wildlife Service likewise prepared information and evaluations regarding potential conflicts with fish and wildlife resources. A joint meeting of these three Interior agencies was held in June 1975, to present and discuss all background information. Subsequent to this meeting initial preferences were identified by the BLM field office and forwarded to the GS field office. At this time, BLM requested that GS develop a resource estimate of the tentative proposed sale area. In the two

Figure I-2.

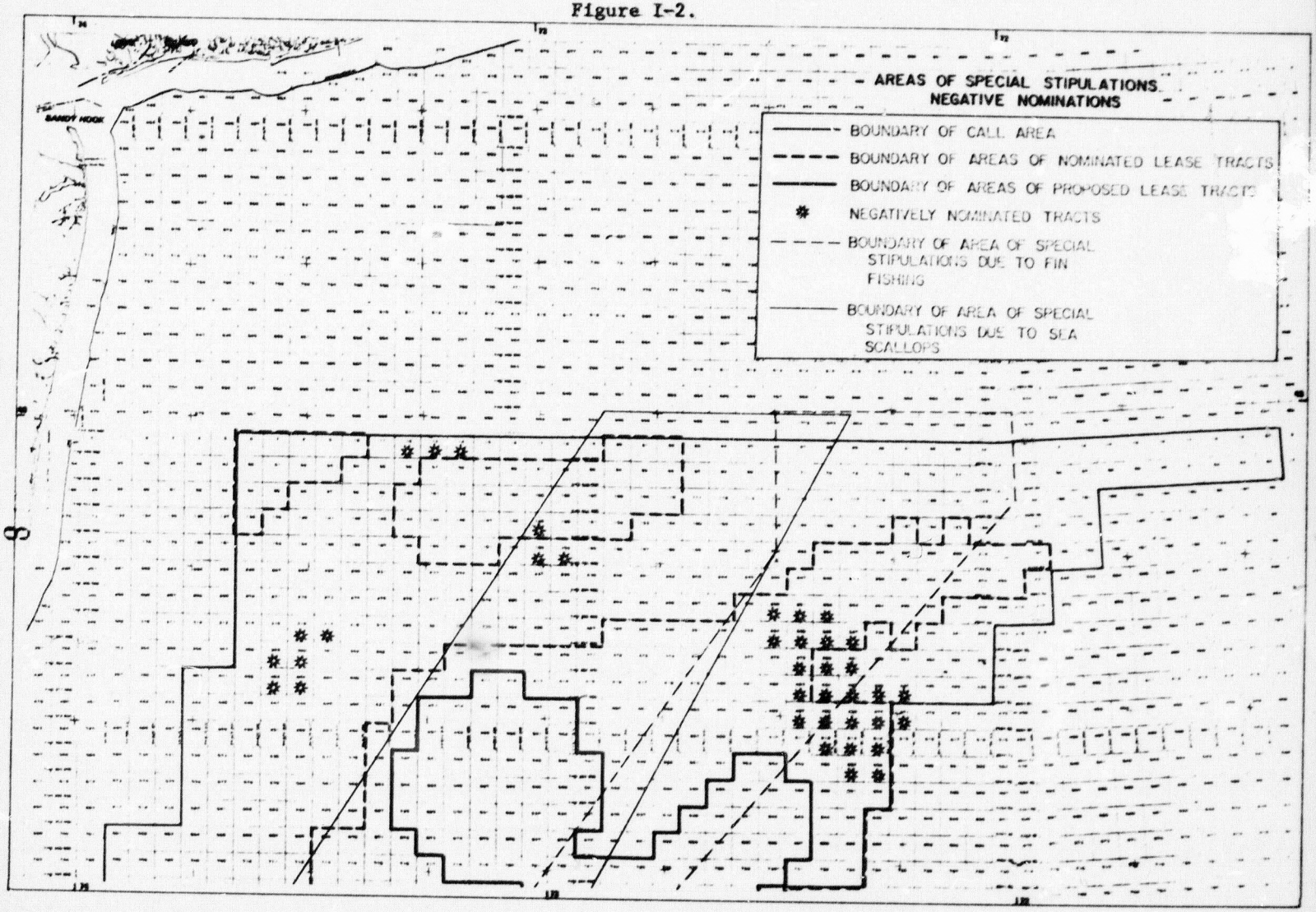

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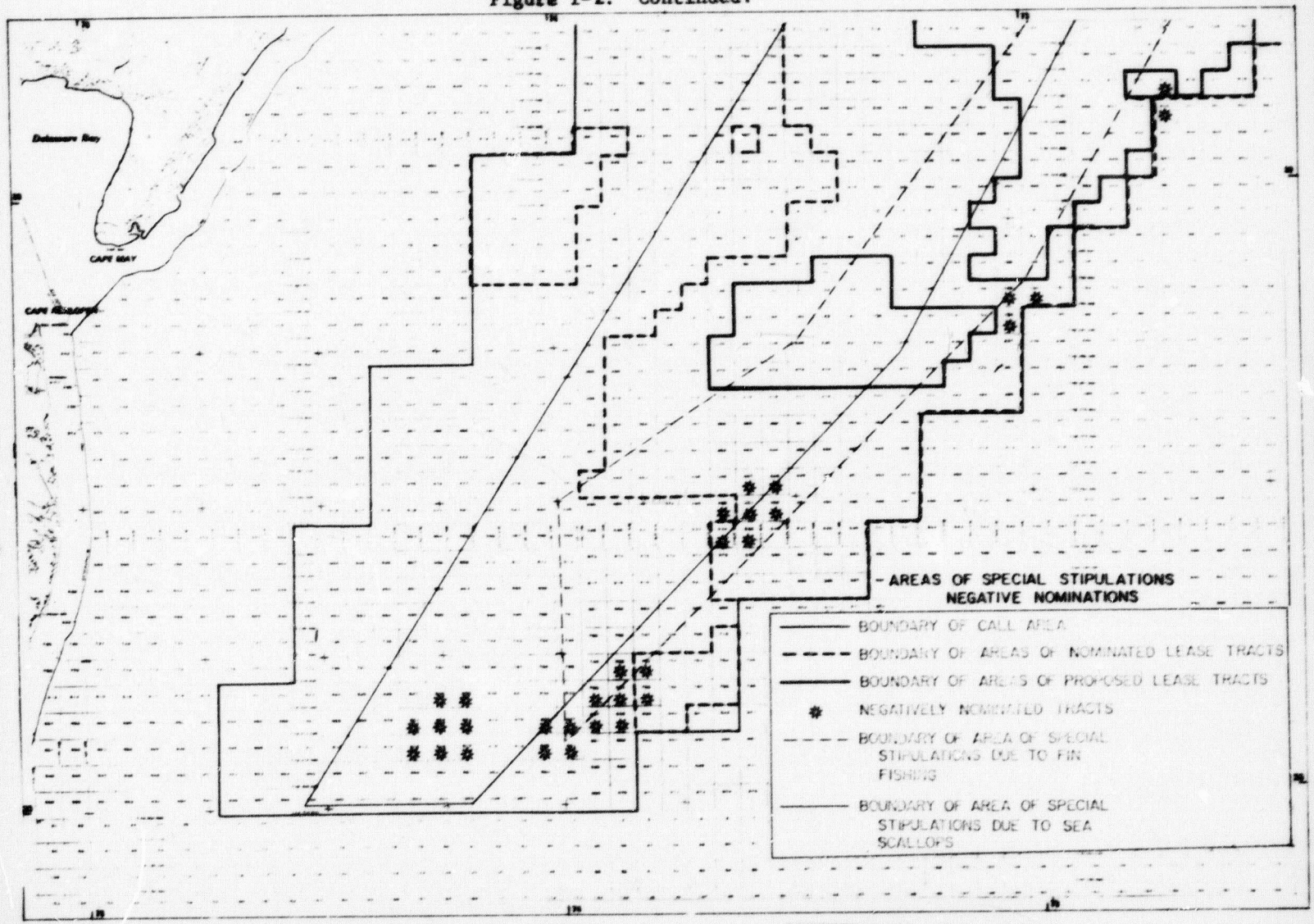
Figure I-2. Continued.



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weeks following the June meeting, the Geological Survey finalized its list of field level tract preferences.

Another meeting was held July 1, 1975, between the BLM and GS field offices, to develop a joint recommendation on tract selection to be forwarded to their respective headquarters offices. Representatives of the Mid-Atlantic State governments were invited to participate. At this meeting the environmental and socio-economic data were presented in condensed form. Geologic information and the results of the Call for Nominations were presented; and the initial tract selection preferences of the GS and BLM field offfices were discussed. After this meeting, the BLM and GS field offices submitted a joint recommendation to their respective headquarters offices.

The Washington headquarters' offices of BLM and GS met to review the field level recommendation and develop the tentative tract selection to be approved by the Secretary. Representatives of the Mid-Atlantic States were invited to participate. Tentative tract selections were announced August 20, 1975. Through this tract selection process the 557 tracts nominated were reduced to 154 tracts tentatively selected for this proposal. The GS has estimated, based on the geologic position of these tracts and on past leasing results, that about 60 percent, or 92 tracts, of this proposed sale area may actually be leased in the event the sale is held.

There have been no previous oil and gas lease sales of Federal or State submerged lands on the Mid-Atlantic Coast in the United States. In addition, this was the first Call for Nominations in the Mid-Atlantic area. There have, however, been several unsuccessful test wells drilled onshore on the Mid-Atlantic coastal plain.[1]

2. Evaluations

As a first step, tracts considered by industry and the GS to have high hydrocarbon potential were identified. These tracts were then examined for possible environmental conflicts or hazards and some were eliminated.

Specifically, evaluations considered the following factors relating to resource potential, resource extraction, possible conflicts, and environmental degradation:

(1) Industry nominations.

(2) Geological and geophysical data, including GS estimates of oil and gas potential of tracts based on this information.

(3) Resource estimates.

(4) Geologic hazards. (Based on bottom sediments, faulting, earthquake potential, etc.)

(5) Current technology.

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[1] However, submerged lands in North Carolina State waters have been under lease since 1957. Test wells in Pamlico and Albemarle Sounds have been unsuccessful in finding oil and gas.

(6) General climatology and seasonal weather patterns (visibility, temperature, winds, storms, precipitation).

(7) Physical oceanography (sea temperatures, surface circulation including currents, waves, swells, and tides).

(8) Physical hazards (ocean dumping areas, military activities, sites of unexploded ammunition, undersea cables, navigation lanes, shipwrecks, harbor areas).

(9) Oil spill trajectories and time to shore.

(10) Commercial and sport fisheries.

(11) Marine and intertidal biological communities.

(12) Onshore biological communities.

(13) Rare and endangered species.

(14) Archaeological and historic sites.

(15) Onshore and offshore outdoor recreation.

(16) Existing infrastructure relating to the petroleum industry in the region (refining, pipelines, oil terminals).

(17) Socioeconomic characteristics of the region (including population distribution, labor force characteristics, etc.).

(18) Transportation network.

(19) Land use.

(20) Water quality.

(21) Air quality.

(22) Onshore soils and vegetation.

Environmental and other considerations which led to elimination of certain tracts were: (1) tracts which the commercial fishing industry, with the concurrence of FWS, NOAA, and the coastal States, believed should be eliminated because of their importance to fisheries, and (2) geological hazards. Interference with navigation was also considered and tracts wholly within traffic lanes were excluded. Figure I-2 indicates (1) the area open to nominations, (2) tracts nominated by industry, (3) negatively nominated tracts (tracts which received comments reflecting a desire that they not be selected for environmental or other reasons), (4) areas for which comments indicated that special stipulations should be developed if leased, and (5) the tracts tentatively selected for this proposed sale.

D. Activities Resulting from the Proposed Sale

The amount of commercial activity which may be generated in the Mid-Atlantic as a result of this proposed sale is dependent on many variables. Chief among them would be the availability of capital, man-power, equipment, and the amount of recoverable resources proven. Distribution of recoverable resources, the ratio of oil to gas, geologic, economic, and other factors will affect the number of platforms, wells, and so forth needed to extract a given amount of resources.

1. Summary of Activities Expected to Result from the Proposed Sale[1]

It is expected that exploratory drilling for oil and gas, conducted from mobile drilling rigs or ships, will commence within one year of the proposed sale date. The most active exploratory drilling would probably take place in the first five years after the proposed sale date,[2] and most exploratory drilling would be completed within five to ten years of the proposed sale. Development well drilling, conducted from fixed platforms, could begin within three years of the commencement of exploratory well drilling, and continue for 10 to 15 years. Some service facilities onshore would be required to support exploration and development activities.

Production is expected to commence in 1981. Most platforms would be producing by 1990, about the time of peak production. Since water

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[1] A more detailed analysis of these activities and their impacts is made in Section III.A. Section III.D.1.a. contains a more detailed analysis of the onshore implications of the activities anticipated.

[2] Leases are issued for a term of 5 years and can be extended for additional one year periods, as set forth in 43 CFR Part 3302.2.

depths of less than 200 meters are involved, conventional platforms are anticipated. Gravity structures (or concrete), are not expected to be used. Production is expected to be transported to shore via pipelines. Small gathering lines would connect production from individual platforms to large diameter pipelines which would carry it to shore in pipeline corridors. While proposed stipulations (Section IV.E.) seek to prevent transportation of oil by tanker to the extent possible, use of tankers for transportation cannot be absolutely ruled out at this time.

Pipeline corridors would proceed to terminals onshore and on to existing refineries and new gas processing plants. If tankers were to be utilized, they would proceed to terminals at the existing Mid-Atlantic refineries. Barging for transporting continuous production will be prohibited by stipulation (except in emergencies) and tankers offloading to barges in estuaries or bays is not anticipated. It is estimated that there will be up to a 25-year well life. Since there is an overlap in the stages of oil and gas operations, peak activity would occur in the early-to-mid 1980's, while peak production would not occur until about 1989 or 1990.

A detailed description of oil and gas operations may be found in Appendix 4.

Table I-1 indicates the acreage and range of activities and requirements expected to result from this proposed sale. A detailed discussion

of the activities that may result from this proposal and their impacts on the environment can be found in Section III.A. later in this statement.

It is possible that this initial activity, if exploration is successful in finding resources, could result in future activities in this Baltimore Canyon Trough area that could extend exploration and development activities beyond the timeframes discussed here. However, any additional lease sale proposals would be subject to separate environmental analysis at a later time, to consider the impacts of further commitment of this Mid-Atlantic area to oil and gas development.

Table I-1. Acreage and Facilities and Activities Expected to be Required to Develop Hydrocarbon Resources Within the Proposed Sale Area

	Based on USGS estimates for this Proposed Sale (25 Year Field Life)[1]	Based on high discovery case (20 Year Field Life[2])
Note: Numbers of anticipated facilities are not necessarily proportional to the amount of estimated recoverable resources, because of differences in assumed development strategies and other assumptions.		
a. Acres proposed to be offered	876,750	
Acres anticipated to be leased	523,756	
b. Wells		
--exploratory	60-240	575
--producing	200-800	880
c. Rigs (maximum working at one time)		
--exploratory	5-20	10
--development	5-20	15
d. Platforms	10-50	44
e. Miles of Offshore Pipeline	100-450	570
f. Terminal/Storage Facilities	1-2	4
g. Onshore Operations Bases	1-2	4
h. Gas Processing Plants (Units with capacity of 300 to 500 mmcf/d)	3-6	8
i. Tankers (if utilized)	Contingent upon technologic and economic considerations; unknown at this time.	

[1] 0.4 to 1.4 billion barrels of oil and 2.6 to 9.4 trillion cubic feet of gas, based on USGS September 1975 sale-specific estimates.

[2] 2.6 billion barrels of oil and 12.8 trillion cubic feet of gas, based on USGS January 1975 estimates.

Table I-1. Continued.

Estimated Total Weight of Drill Cuttings (Average Well Depth 15,000 Feet)

Exploratory wells	64,770 - 259,080 tons	(620,713)[1]
Development wells	215,900 - 863,600 tons	(949,960)
Total	280,670 - 1,122,680 tons	(1,570,673)

Estimated Total Weight of Drilling Muds Retained in Well Bore, Adhering to Cuttings, or Entering Marine Environment (Unrecycled)[2]

Exploratory wells	41,490 - 165,960 tons	(397,612)
Development wells	13,830 - 55,320 tons	(60,852)
Total	55,520 - 221,280 tons	(458,464)

Estimated Total Volume of Formation Water Discharged (Assumes a 1:1 ratio over field life)

0.4 to 1.4 billion barrels (2.6)

Estimated Maximum Amount of Marine Sediment Disturbed by Pipeline Burial

800,000 - 3,600,000 cubic yards (4,560,000)

Estimated Total Land Use Requirements for Directly-Related Onshore Facilities[3] (Excludes pipeline rights-of-way)

160-645 acres

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[1]All figures in parentheses are based on high discovery case and correspond to numbers of facilities indicated in the right hand column on the preceding page.

[2]While it is not possible to estimate the relative amounts of drilling muds retained in the wellbore and amounts entering the marine environment, the bulk of unrecycled drilling muds is retained in the wellbore.

[3]Facilities included in this estimate are indicated in Section III.D.1.d. Other land use requirements are also discussed therein.

2. Environmental Studies Program

In order to fulfill its requirement under the marine minerals management goals of the Department of the Interior, the Bureau of Land Management (BLM) is developing a comprehensive multi-year environmental study plan for the Mid-Atlantic OCS area. This plan shall represent an extension of the first year study plan under which the Mid-Atlantic OCS Environmental Program was initiated in January 1975. The data generated by these studies will represent an important addition to the existing data base and will enhance the Department's ability to make management decisions that will ensure environmental integrity during oil and gas exploration, development, and production in this Mid-Atlantic region.

The BLM has established broad objectives for environmental studies programs in order to satisfy various legislative requirements, including those of the Outer Continental Shelf Lands Act, the Submerged Lands Act and the National Environmental Policy Act. These objectives are:

1) the acquisition of information about the OCS environment that will enable the Department and the BLM to make better management decisions regarding the development of mineral resources on the Federal OCS;
2) the acquisition of information about the OCS environment which will enable the Department and the BLM to detect the impacts of OCS oil and gas exploration and development on the marine environment, and information which will enable the detection of environmental changes

which may occur as a result of oil and gas operations;

3) the establishment of a basis for prediction of impact of OCS oil and gas activities in frontier areas;

4) the identification of sensitive habitats, potential geological hazards, and other factors of concern on the marine environment; and

5) the acquisition of impact data that may result in the modification of leasing stipulations, and OCS Operating Orders, Notices to Lessees, and guidelines permitting efficient resource recovery while also insuring the protection of the marine environment.

The environmental studies program for the Mid-Atlantic OCS is designed to acquire three distinct types of data: benchmark, descriptive, and predictive. Benchmark data are both qualitative and quantitative for which an acceptable statistical significance can be established. This type of data is collected prior to oil and gas production so that any environmental impacts can be detected by monitoring the same parameters during the production stage. Descriptive data fall into two categories. The first is nonquantitative, or semi-quantitative descriptions of the morphological aspects of the environment which identify unique or special areas. The second is nonquantitative biological or chemical data for which statistical significance can not be feasibly established. These data are primarily used in support of the analyses of effects which are observed through

the benchmark and/or predictive data studies. They may also serve as indicators of environmental stress which could lead to the initiation of special studies designed to determine the sources and effects of the stress. Predictive information is primarily composed of physical processes data which can be used to determine the fate of pollutants, and biological effects data which can be used to predict and determine stress levels imposed by oil and gas development.

The collection of the various types of data described above is the final step in a three-stage process which leads to the development of an integrated, multi-disciplinary environmental studies program.

The BLM will proceed to develop a multi-year environmental study plan for the Mid-Atlantic.

At present, the program is envisioned as a long-term study which will be in effect for a minimum of three to five years, and most likely will continue for the duration of exploratory drilling, development drilling, establishment of production platforms, the laying of pipelines, and other related activities in the Mid-Atlantic area. Original budgeting and planning were based on an initial three-year period of intensive study; a slow decline in funding and effort over the succeeding two years; and a maintenance, or sustaining level of effort and funding for an indefinite number of years to monitor the effects of OCS oil and gas exploration and development over the

long-term. Present estimates indicate that this monitoring period could range from five to fifteen years, but these estimates will continue to be revised depending upon the level of oil and gas activities that may occur in the region.

In addition, with the experience gained during the first year's study effort in the Mid-Atlantic region, the levels of funding and effort, the desired data products, and the timing may be modified. However, it must be emphasized that all funds are obligated on a year-to-year basis even though programs may be planned for longer periods of time. This permits flexibility in selecting the parameters to be measured, the location of sampling stations, the evaluation of the contractor's performance, the evaluation of the data, the institution of special studies, and other factors.

A brief summary follows of the ongoing first year environmental studies program, initiated in early 1975, aimed at establishing the chemical, biological, and geological benchmarks for the Mid-Atlantic OCS.

The Virginia Institute of Marine Sciences (VIMS) was awarded a contract by BLM in June 1975 to conduct a marine chemistry and biology program for the purposes of delineating natural communities and establishing ambient levels of high molecular weight hydrocarbons and selected trace metals in the water column, organisms, and particulates.

The U.S. Geological Survey is currently conducting baseline studies under a memorandum of understanding with BLM for the purpose of

describing the geological and geophysical properties of the Mid-Atlantic region, and establishing chemical benchmark data for sediments. Field investigations were begun in April 1975, and involve mapping of geologic hazards, selecting sedimentary environments for sampling, sediment transport studies, and establishing ambient levels of hydrocarbons and selected trace metals in the sediment.

The National Oceanic and Atmospheric Administration (NOAA) has been participating in the Mid-Atlantic baseline effort since November 1975 under an interagencu agreement with BLM. BLM is also cost sharing with NOAA for the collection of meteorological and wave information from two meteorological buoys presently deployed in the Mid-Atlantic and in the New York Bight area. The NOAA will provide to BLM interpretive information from historical sources relating to the physical oceanography of the region.

I. Field and Laboratory Program for the Mid-Atlantic OCS

A. Water Column - biological, chemical, and physical oceanographic data shall be collected during the four biological seasons in the area. (VIMS)

1. Zooplankton - the samples obtained will be subjected to hydrocarbon analysis, trace metal analysis, and taxonomic studies.

2. Neuston - the samples will be collected every three hours during a twenty-four hour period for each of the four biological seasons and the collected material will be subjected to hydrocarbon, trace metal and taxonomic analyses;

3. Marine Heterotrophic Bacteria - surface samples will be collected and the ratio of hydrocarbonoclastic to aerobic heterotrophic bacteria will be determined, along with the identification of the predominant associated bacteria taxa. Subsurface samples will also be collected and analyzed for the same parameters as the surface samples. Additional studies will also be carried out with the collected bacteria in order to determine the rates of oil and distillate product degradation; the effects of these compounds on bacterial cultures isolated from the water column; and the effects of these products on the mineralization of chitin and cellulose for each sampling season.

4. Particulate Hydrocarbons - water samples will be collected at one meter and at near bottom depths, the water will be filtered and the collected particulates will be analyzed for hydrocarbon content for each sampling season.

5. Dissolved and Surface Film High Molecular Weight Hydrocarbons (C_{14}) - additional particulate samples collected from one meter depths and surface films will be collected; both will be analyzed for high molecular weight hydrocarbons for each sampling season.

6. Particulate and Dissolved Organic Carbon - will be determined on water samples obtained at one meter and near-bottom depths for each sampling season.

7. Particulate Trace Metals - the trace metal content of particulate samples collected at the surface and near the bottom will be determined for each sampling season.

8. Dissolved Micronutrients - will be determined for at least two depths (surface and-near bottom) for each sampling season.

9. Dissolved Oxygen - will be determined at a minimum of two depths (surface and near-bottom) for each season.

10. Salinity - will be determined at a minimum of two depths (surface and near-bottom) for each season.

11. Salinity, Temperature, Depth, and Dissolved Oxygen - a minimum of 24 S.T.D./D.O. casts will be performed for each season.

12. Expendable bathythermographs - shall be taken between each water column station for each season.

B. Benthic Sampling Program - biological, chemical, and physical oceanographic data will be collected during the four biological seasons in the area. During winter and summer, samples will be collected at fifty-one stations and during the fall and spring, samples will be collected at twenty-four stations. (VIMS)

1. Microfauna, Macrofauna, Marine Bacteria - samples for taxonomic studies and for the determination of the hydrocarbonoclastic to aerobic heterotophic bacterial ratios shall be taken.

2. Total Organic Carbon, Trace Metals, and Hydrocarbons shall be determined on sediment samples obtained at each station.

3. Trawls and/or Dredges - sampling for both epifauna and macroinfauna will be carried out four times during the year; samples will be collected for taxonomic, trace metal, hydrocarbon, and histopathological studies.

4. Camera Stations - bottom photographs will be taken at each station to obtain data on the spatial distributions of epibenthos.

5. Dissolved Oxygen, Salinity, and S.T.D./D.O. Casts - will be obtained at each benthic station at a minimum of two depths (surface and near-bottom) for each season and station.

6. Expendable Bathythermographs - will be deployed between each benthic station.

7. Dissolved Micronutrients - will be determined for at least two depths (surface and near-bottom) at all S.T.D./D.O. stations during each season at the benthic stations.

C. Potential Shallow Hazards Evaluations (USGS)

1. Uniboom, Minisparker, and 3.5 echo sounder systems profiles.

2. Sediment Transport Studies
3. Vibracores
4. Gravity Cores
5. Side-scan sonar records
6. Grab sampler
7. Grain size and texture analyses

D. Additional Bottom Sediment Studies--Transport Rates and Areas of Active Transport (USGS)

1. Submersible observations (miniature submarines)

2. Observations over time of pipes emplaced on the ocean bottom.

3. Data from a bottom-mounted tripod containing a camera, current meter, and sediment collector.

4. Carbon-14 dating of core samples.

5. Suspended sediment samples and transmissometer measurements from the water column.

E. Physical Oceanography and Meterology

1. Virginia Sea Wave Climate Model (VIMS)

2. Summerization and interpretation of historical physical oceanographic and meterological information for the Mid-Atlantic. (NOAA--EDS/CEDDA)

3. Meterological buoy (NDBO-NOAA)
   Collecting data on wind direction and magnitude, air temperature, atmospheric pressure, sea surface temperature, significant wave heights and periods.

Further information concerning the geologic benchmark study is contained in Section II.A. This section also contains preliminary information obtained in these environmental studies. Section II. F. also contains preliminary information obtained from biological benchmark studies; however, because of the seasonal nature of the biological

studies and the longer time required for analysis in many cases, not as much information is available concerning the biological and chemical aspects of the program as is for the geological aspects.

E. Relationship of This Proposed Sale to Development of Proposed OCS Planning Schedules for Possible OCS Oil and Gas Leasing and the Department's Program to Accelerate OCS Oil and Gas Leasing Nationwide

Proposed OCS Planning Schedules are developed in order to project the timing, size, and location of specific lease sales for an OCS leasing program. General sale areas are identified and, at a later date, tentative acreage figures are set through the tract selection process for each proposed sale on the basis of broad resource knowledge and environmental evaluation. The goal of the proposed schedule is to provide for orderly development of OCS oil and gas resources and to maintain an adequate contribution of OCS production to the national supply.

In developing a proposed OCS planning schedule the Department considers the three leasing objectives that have been set for the Departmental OCS program. These objectives are: 1) orderly and timely resource development; 2) protection of the environment; and 3) receipt of fair market value. The principal factor in planning for OCS leasing is to strive for a supply of oil and natural gas adequate to meet the demand for these resources, consistent with the protection of environmental values. This is the foundation of and basis for the existence of any OCS leasing program. The tentative acreage selection process that follows must consider the need to balance supply with demand. Acreage is tentatively selected in sufficient amount to engender industry interest and promote a fair market return.

The proposed OCS planning schedule is essential as a program planning document to enable the Department to proceed in an orderly and timely fashion with its process of considering the several proposed and possible lease sales identified in that document. The proposed OCS planning schedule aids the Department of the Interior in establishing the order in which areas will be examined and in planning the work assignments of personnel and the allocation of resources for the environmental and other studies ennumerated. The proposed OCS planning schedule also serves to apprise Federal, State, and local agencies, industry, and interested members of the public of the time frame for consideration of potential leasing in the identified areas of the OCS. The proposed OCS planning schedule is a flexible document that is subject to revision at any time. More particularly, the consideration of any proposed or possible sale is subject to being terminated, modified, deferred, or advanced.

In May 1974, the Department announced that it would prepare a draft environmental impact statement on the proposed program to accelerate OCS oil and gas leasing from 3 to 10 million acres in 1975. This proposal considers the entire United States' continental shelf. A draft environmental impact statement on this proposed program was published in October 1974, submitted to CEQ and made available to the public for review and comment. Public hearings were held in February

1975 on this draft statement in Anchorage, Alaska, Beverly Hills, California, and Trenton, New Jersey.

In November 1974, the Department modified the goal of its proposed accelerated OCS oil and gas leasing program nationwide from leasing ten million acres in 1975, to holding 6 proposed lease sales[1] in 1975 and 6 possible lease sales[2] per year for the period 1976 through 1978, offering prospects in each frontier area[3] by the end of 1978. Accelerated leasing remained an intergral part of the proposal, but the specific acreage figure had been eliminated.

On November 14, 1974, a new proposed OCS planning schedule was announced by the Department of the Interior at a conference with coastal States' Governors. This 1974 proposed schedule replaced an earlier 5-year schedule that had been issued in July 1973.

The proposed OCS planning schedule issued in November 1974, was revised in June 1975 to reflect changes in the timetables for considering certain sales listed on that schedule. This June 1975 OCS Planning Schedule (Figure I-3) represents the latest schedule.
The proposed sale under consideration here is listed on this proposed schedule. One additional sale in the Mid-Atlantic is also listed on the proposed schedule.

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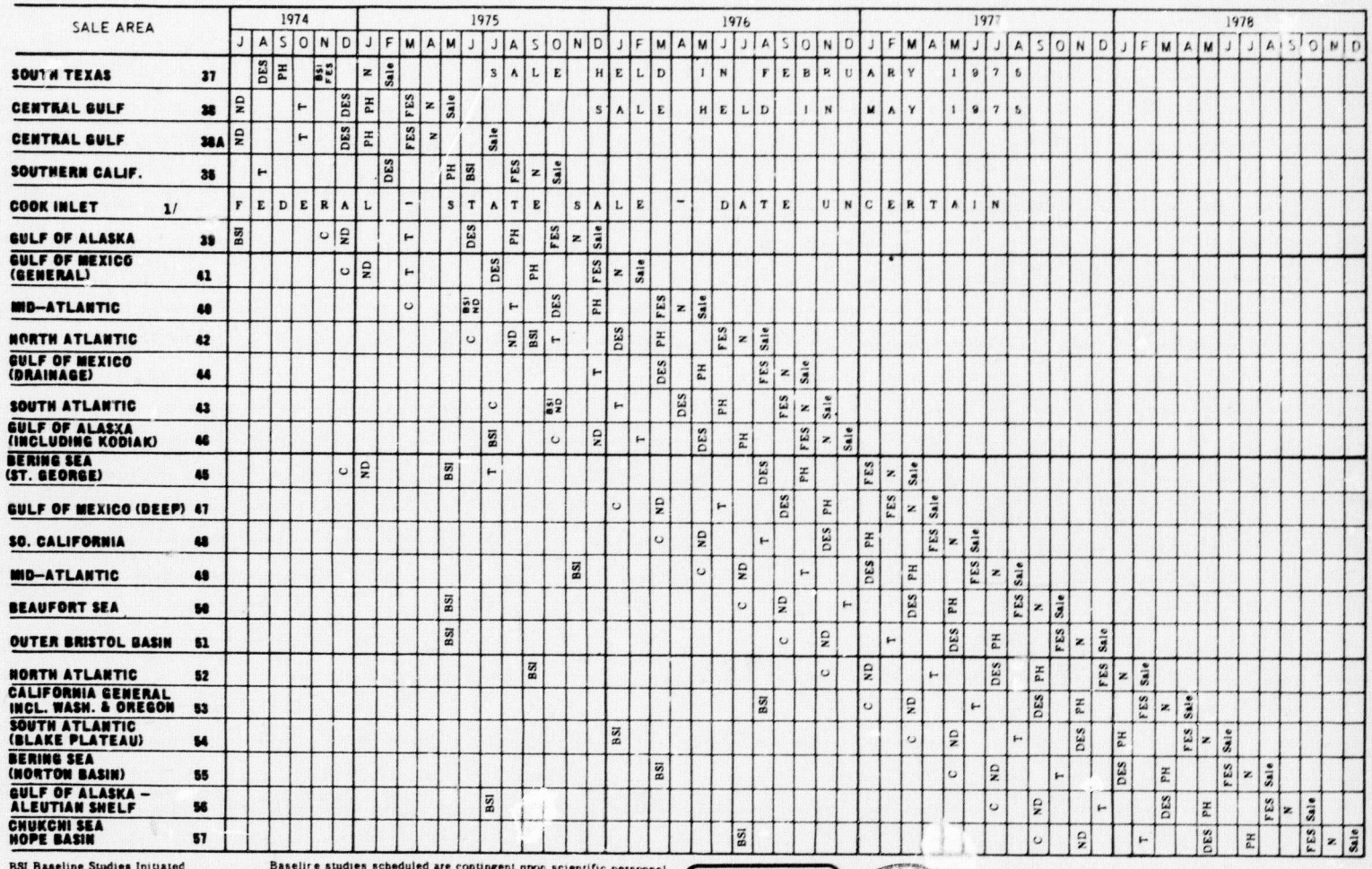
[1]A proposed sale, as used herin, refers to a tentative sale where tract selections have been made for the purpose of preparing a site-specific environmental impact statement.

[2]A possible sale, as used herein, refers to a tentative sale which has been listed as a proposed planning schedule but has not reached the tract selection stage of the consideration process.

[3]Frontier area refers to any of the 17 recognized OCS areas in which there has been no prior Federal oil and gas leasing.

Figure I- 3. PROPOSED OCS PLANNING SCHEDULE

JUNE 1975
(REVISES NOVEMBER 1974 SCHEDULE)



BSI Baseline Studies Initiated
C Call for Nominations
ND Nominations Due
T Announcement of Tracts
DES Draft Environmental Statement
PH Public Hearing
FES Final Environmental Statement
N Notice of Sale
1/ State May Conduct Sale

Baseline studies scheduled are contingent upon scientific personnel and equipment being available to perform the studies.

Sales are contigent upon technology being available for exploration and development. A decision whether to hold any of the lease sales listed will not be made until completion of all necessary studies of the environmental impact and the holding of public hearings; as a result of the environmental, technical, and economic studies employed in the decision - making process, a decision, may, in fact, be made not to hold any sale on this schedule.

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

U.S. DEPARTMENT OF THE INTERIOR
March 3 1849

Curt V. Berklund

Director,
Bureau of Land Management

Some of the major resource, environmental, and technological factors weighed in developing the proposed OCS planning schedule issued in November 1974, are as follows:

- Review of the Council on Environmental Quality's (CEQ) environmental reports concerning the Gulf of Alaska and Atlantic OCS, consideration of their ranking of areas by environmental risk and their concern for adequate regulation and utilization of technology. The Department responded to this report, outlining the steps being taken on the basis of CEQ's recommendations.

- Review of the results of Interior's survey of industry, State and local governments, and interested members of the public concerning resource potential, leasing preferences, and matters of environmental concern. These results were published in June 1974.

- Collection and examination of considerable amounts of geological resource data gathered in seismic surveys of these areas.

This proposed OCS planning schedule does not represent a decision to lease in any of these particular areas. It represents only the Department's intent to consider leasing in such areas and to proceed with the leasing development of such areas if it should be determined that leasing and development in such areas would be environmentally, technically, and economically acceptable. Thus, the modified program proposal to accelerate OCS oil and gas leasing entails the leasing of some of each of the Atlantic, Pacific and Alaska offshore frontier areas by the end of 1978.

The Department revised the content of the draft programmatic environmental impact statement in light of the written comments received on that statement and oral comments submitted at the public hearings held in February 1975. That EIS addresses the proposed program as modified in November 1974, and includes a discussion and analysis of the proposed OCS planning schedule, revised June 1975. A final programmatic EIS has been submitted to CEQ and was made available to Federal, State, and local agencies, and interested members of the public on July 7, 1975.

On September 29, 1975, the Acting Secretary approved a program to accelerate oil and gas leasing on the Outer Continental Shelf. The Department's decision was made only after conducting in-depth studies based on the best information available considering environmental, technical and economic aspects of the proposal to accelerate OCS leasing.

As in the case of this proposed Mid-Atlantic OCS oil and gas lease sale No. 40, the Department has committed itself to prepare site-specific draft environmental impact statements on each OCS oil and gas lease sale that is proposed. This is in addition to preparation of the OCS Final Programmatic EIS and the approval of the accelerated OCS oil and gas leasing program.

The approved accelerated leasing program that includes proposed sales in the Mid-Atlantic does not constitute a decision on this proposed lease sale. This site-specific proposal will be considered on an individual basis after the waiting period for the final site-specific EIS has expired, and only after the Department has considered the environmental, technical, and economic aspects of this particular lease sale proposal.

In the planning of the accelerated leasing program, a request for comments from all concerned parties on potential OCS oil and gas leasing appeared in the Federal Register in February 1974. The Bureau of Land Management and the U.S. Geological Survey reviewed all the responses received, and on the basis of these responses, determined several rankings of the 17 OCS areas, including the Mid-Atlantic, which were delineated in the request. The Mid-Atlantic was ranked fifth among the 17 areas in a composite ranking according to its resource potential and preference. Four petroleum companies also ranked the 17 areas on the basis of environmental hazard. From least to greatest hazard,[1] on a scale of one to ten (ten being greatest hazard), the Mid-Atlantic was ranked seventh. Detailed analyses of the factors affecting this environmental ranking were not provided.[2]

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[1]The Council on Environmental Quality (CEQ), in its Oil and Gas--An Environmental Assessment (1974), ranked areas for environmental risk in the Atlantic and Gulf of Alaska only. They placed the central Baltimore Canyon (essentially including all of the potential lease tracts) third most hazardous of six generalized areas in the Atlantic.

[2]Report on the Responses Received in Reply to the Request for Comments on Potential Future Outer Continental Shelf Oil and Gas Leasing, Bureau of Land Management (no date).

This request for comments and ranking procedures was the first tier in the two-tier nomination system for OCS leasing, the second procedure being the tract selection process.

F. Relationship to Other Governmental Programs

1. Federal

a. Administrative and Regulatory Responsibilities

As indicated in Section I.C., leasing procedures and pre-leasing evaluations and analyses are the responsibility of the Department of the Interior - primarily the Bureau of Land Management and the U.S. Geological Survey. The U.S. Fish and Wildlife Service helps design environmental studies and acts in an advisory capacity through much of the leasing process.

Several agencies, including Interior agencies, are involved in regulatory aspects of offshore oil and gas operations which involve their program areas. Offshore structures require permits to assure that navigation is unobstructed (permits are issued by the Department of Defense, Secretary of the Army, Corps of Engineers), and to ascertain that structures are properly marked to protect navigation (permits are issued by the Department of Transportation, U.S. Coast Guard). Establishment and enforcement of navigational safety is also a responsibility of the U.S. Coast Guard. Pipeline safety is regulated by the Materials Transportation Bureau (Office of Pipeline Safety Operations) in the Department of Transportation. The U.S. Geological Survey also considers safety features of design specifications in approving pipeline applications. BLM grants the rights-of-way for pipelines through the Federal Outer Continental Shelf area.

The Federal Power Commission (FPC) and the Interstate Commerce Commission regulate pipelines linked to interstate commerce, and the FPC sets the wellhead price of OCS-produced gas.

Permits for and regulation of oil discharged are under the jurisdiction of the Environmental Protection Agency (EPA), by the authority of the Federal Water Pollution Control Act (FWPCA), as amended in 1972. Both the Coast Guard and the Geological Survey perform surveillances for oil spills and discharges.

The FWPCA also provides for a National Oil and Hazardous Substances Pollution Contingency Plan for which EPA and the Departments of Interior, Transportation, and Defense all share responsibility.

In addition, the following Federal Government agencies are represented on the OCS Advisory Board: Geological Survey, Fish and Wildlife Service, Environmental Protection Agency, and National Oceanic and Atmospheric Administration. The Board advises the Bureau and the Department in the design and implementation of environmental research projects related to oil and gas exploration and development on the OCS.

The Board recently was reorganized on a two-tier principle. The Board itself considers policy matters and is made up of Federal

and State representatives in policy positions. A technical committee of the Board, the OCS Environmental Studies Advisory Committee, consists of scientists and technical experts who advise the Board on technical matters, such as the composition of the environmental studies.

b. Other Federal Activities on the Mid-Atlantic OCS

Principal military use of the Mid-Atlantic OCS is by the Navy. Gunnery, aircraft, missile, and submarine exercises and activities presently take place in this region under the jurisdiction of the Commander, Eastern Sea Frontier. Air National Guard exercises also take place in designated corridors over the OCS. Rocket launches, principally in meteorological experiments, are conducted by the National Space and Aeronautics Administration from Wallops Island, Virginia; the rockets' trajectories carry them over the OCS.

2. State and Local

The Governors of all of the coastal states are represented on the OCS Research Management Advisory Board. Following are discussions of State and local programs and legislation which have a significant effect, or will be affected by OCS activities.

a. Coastal Zone Management

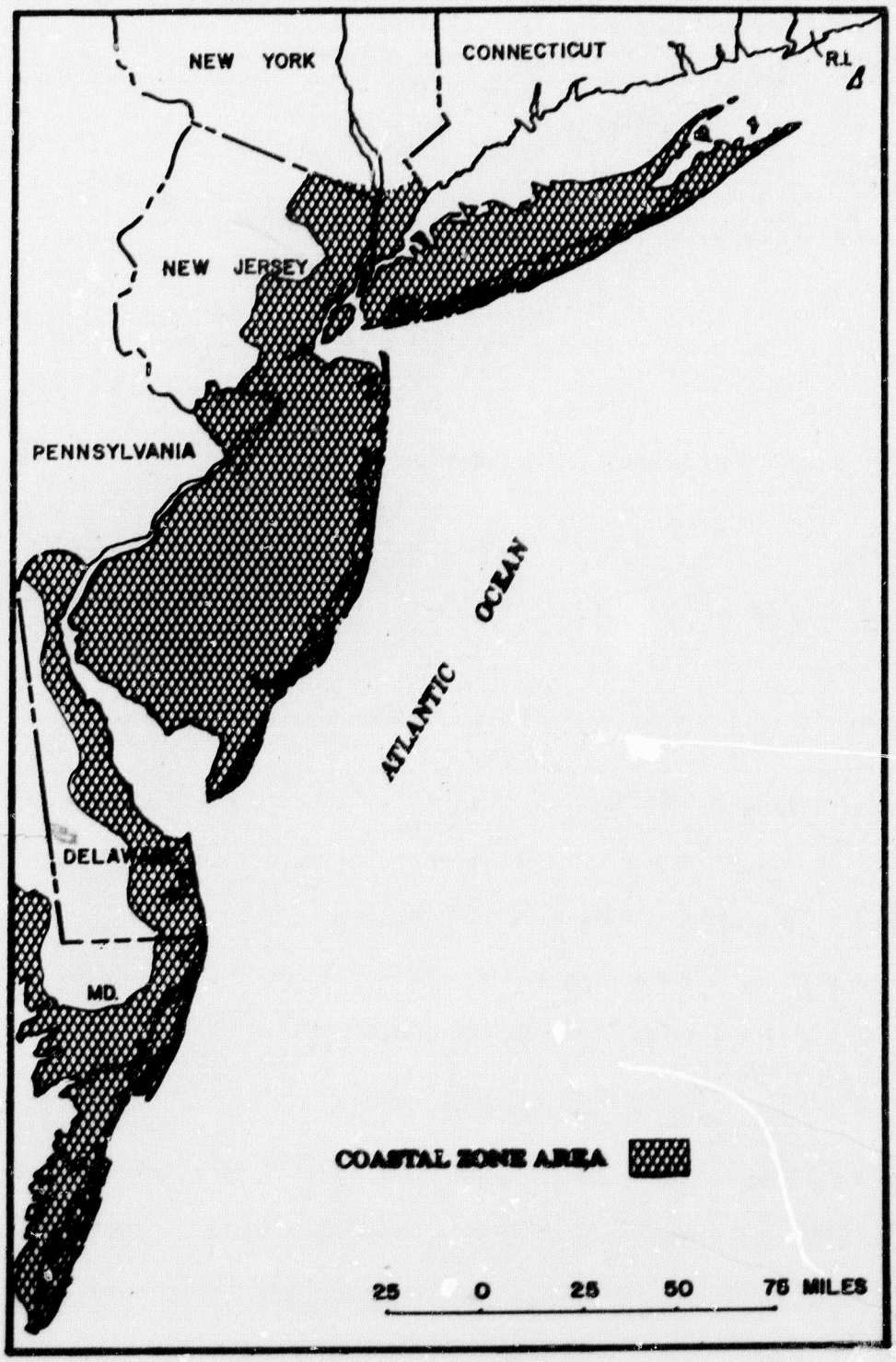
The Coastal Zone Management Act (CZMA) of 1972 (P.L. 92-583), administered by the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, provides grants-in-aid to States

for the development and implementation of management programs to control land and water uses in the coastal zone. In order to qualify for implementation monies, a State must develop its management program within three years. The policy which the Act established is aimed at balancing protection of the coastal environment with development and economic interests. The Act also provides for consistency of Federal programs with approved State plans.

While the Act allows individual States much leeway in devising management plans and allocating responsibilities, both among State agencies and to regions and localities, the States themselves must approve the management plans. Therefore, the types of development permitted in the coastal zone, including any that might be associated with offshore oil and gas operations in the event this proposed sale is held, can ultimately be broadly controlled by the States. The map on Figure I-4 depicts the relevant portions of the coastal zone as tentatively identified by the respective States.

Following is a description of the coastal zone planning programs presently ongoing in each of the Mid-Atlantic States.

Figure I-4.



MID-ATLANTIC REGION

New York

New York was awarded its first-year development grant in November 1974. The effort to date has focused on:

- Establishing a public participation process
- Identifying goals and policies
- Identifying existing plans and programs affecting the coastal zone
- Evaluating local controls and plans for their effectiveness
- Evaluating factors which could be used to establish definitive coastal zone management boundaries

The State has contracted with the Nassau-Suffolk Regional Planning Board to develop, in concert with the Regional Marine Resources Council and other interested public and private entities, a list of goals and policies relevant specifically to Long Island coastal areas.

For study purposes, all of Long Island, as well as the New York City area, is included within the tentatively identified coastal zone management boundaries (Figure I- 4). The State does not presently have, as part of its study plan, an element which specifically addresses proposed Outer Continental Shelf oil and gas development.

New Jersey

New Jersey's second-year development grant was approved in June 1975. The second year effort is predominantly a continuation

of the following activities initiated during the first year:

- Development of a computer-based information system
- Compilation of an environmental (including social and economic) inventory
- Identification of areas of particular concern
- Determination of permissible land and water use

In addition, the second year effort involves the compilation of a legal inventory of alternative management implementation approaches and an examination of offshore energy resources.

New Jersey's CZM effort is being undertaken in conjunction with the States' Coastal Area Facility Review Act (CAFRA) program, which is discussed in subsection b. below. The effort has involved participation by Federal, State, and local governmental agencies and a variety of elements of the private sector. To date the following general goals pertinent to the OCS program have been identified:

- Manage the most ecologically fragile areas to protect them against inappropriate development
- Permit multiple land and water uses that contribute to economic and environmental diversity
- Develop and promote environmental safeguards for the design and construction of facilities
- Prohibit land and water uses that materially contribute to an already serious level of environmental degradation or resource depletion.

The boundaries for CZM planning efforts include all counties which have shorelines and river banks subject to tidal action. The CZM effort addresses a much larger area (Figure I-4) than does CAFRA, which only relates to a narrow band of land along the coast.

Delaware

Delaware received approval for its second-year grant in July 1975. The following general goals, pertinent to the OCS program, have been developed:

- Determine the compatibility and appropriate mixture of uses of the coastal zone
- Protect the inshore and marsh areas from pollution
- Develop and implement criteria, standards, and regulations for control of land and water uses within the coastal zone

The first-year efforts resulted in the letting of contracts for undertaking of the following work elements:

- Assessment of the adequacy of current legal authority
- Development of a wetlands and water resources atlas
- Preparation of wetlands base maps
- Identification and assessment of major water users
- Study on coastal erosion
- Study on storm flooding
- Study of hydrology, geology, and mineral resources
- Preparation of generalized land use maps for Kent and Sussex Counties
- Development of a coastal zone management methodology

Delaware has been instrumental in efforts by the Mid-Atlantic Governor's Coastal Resources Council (MAGCRC)[1] to undertake a study of possible OCS-related activities from a regional perspective. Delaware has submitted grant applications, on behalf of MAGCRC, to the Federal Energy Administration to undertake such an effort. Specifically, the study is designed to develop and plan for an integrated regional approach to managing the onshore impacts and timing of OCS, deepwater port, and other energy-related development.

Maryland

Maryland has received approval for its second-year planning grant. The general objectives of Maryland's CZM effort are:

- To identify and develop mechanisms to protect areas of biological, recreational, aesthetic, scientific, historical, and cultural importance and to identify and provide for the rational growth of areas appropriate for development
- To develop guidelines and standards regarding the conduct of activities occurring in other portions of the State's coastal zone so that they do not adversely affect critical areas or the productivity of the State's coastal areas
- To develop mechanisms, including the setting of priorities, to guide public and private utilization of coastal resources in order to minimize conflicts among uses and to protect the natural resource base on which coastal uses depend.

---

[1] Composed of representatives from New York, New Jersey, Delaware, Maryland, and Virginia.

During the second year the following efforts will be undertaken:

- Identification of critical areas (archeological resources, environmental mapping, geomorphological mapping, developmental critical areas, and submerged lands)
- Identification of permissible uses (spoils disposal study)
- Clearer delineation of CZM boundaries
- Development of criteria and procedures for identifying suitable locations for siting of energy facilities
- Design an overall strategy to address probable onshore development associated with OCS oil and gas production

Maryland's CZM boundaries, for study purposes, include the areas of the lower eastern shore depicted on Figure I-4.

Virginia

Virginia's first-year planning grant was approved in August 1974 and recently amended to extend through October 1975. The following general goals, pertinent to proposed OCS activity, have been identified:

- To progressively improve and maintain the water quality of estuarine rivers, bays and seas
- To preserve, to the maximum extent practicable, the coastal wetlands
- To improve and maintain commercial and sport marine life

- To enhance public and private recreational opportunities
- To encourage economic growth while safeguarding and maintaining use options

The first-year planning effort involved:

- An assessment of public and private activities in the coastal zone
- An examination of existing land use and socio-economic conditions in the coastal zone
- Compilation of a tidal marsh inventory
- Development of a series of shoreline situation reports (including Accomack and Northampton counties)
- A technical assessment related to potential Mid-Atlantic OCS oil and gas development
- An assessment of the siting of key facilities including those generated by OCS activities

A Coastal Zone Advisory Committee, presently comprised of eight state agencies, acts as the primary mechanism for state level coordination. The membership of the committee has been expanded to include representatives of each of the regional planning districts included in the CZM boundaries. Additionally, monies might be provided on a subcontracting basis to the individual planning districts to sustain their involvement in the CZM effort. The entire eastern shore of Virginia, as identified in Figure I-4, is included within the tentatively identified CZM study boundaries.

The efforts most significant to proposed OCS leasing acitivites are the technical assessment and key facilities studies. The technical assessment will evaluate existing technical information on OCS oil and gas related activities. The key facilities effort will identify how the Commonwealth can provide leadership in the siting of key facilities (including those related to OCS development) so as to be able to take into consideration the national as well as state interests.

Pennsylvania

The coastal zone management plan for the Delaware River coastal zone is presently in the planning stages. Pennsylvania is operating under a second year planning grant which runs from July 1975 to June 1976. An implementation grant is anticipated in July 1977. Extensive economic, social, and environmental inventories have been completed. An analysis of the impacts of uses on coastal resources is underway. A methodology is being developed to designate final coastal zone boundaries.

The following are Pennsylvania's major goals:

- Establish and maintain a management program for coastal land and water resources that maximizes the benefits to Commonwealth citizens through a legal and administrative system.
- Coordinate the comprehensive management of coastal land and water uses.
- Promote ongoing citizen participation reflecting public needs and aspirations.

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- Establish a balance of compatible land and water uses which provide for both protection of and development of the coastal zone.
- Promote rational socio-economic growth, reasonable use of resources, and an optimal level and variety of employment opportunities within the coastal zone.
- Improve the environmental and aesthetic quality of the coastal zone for the future benefit and enjoyment of all citizens.
- Maximize recreational opportunity related to the unique resources of the coastal zone.
- Continually evaluate goals and objectives throughout the coastal zone management program.

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b. Special Legislative Restrictions

In addition to the States' coastal zone management programs, existing State laws regulating or controlling development, facility siting, and emission levels have application to the coastal zone. As such, any OCS-related facility development in the coastal zone would be subject to these regulations. All the Mid-Atlantic States have enacted some form of wetlands protection legislation. Three states--New Jersey, Maryland and Virginia--have State environmental policy acts or executive orders requiring environmental impact statements for State-sponsored projects. In several cases, the requirement is limited to projects costing in excess of a certain dollar amount. Certain types of projects are excluded in some states. In addition, three states have special legislation specifically concerning facility siting within their coastal zones.

Delaware's Coastal Zone Act specifically bans certain heavy industries identified in the Act from the defined coastal zone. Examples of developments banned are refineries, petrochemical plants, and steel

manufacturing plants. Also prohibited are new bulk transfer facilities transporting any bulk product from vessels to onshore facilities or vice versa.

In addition to activities absolutely prohibited, the Act creates a permitting system for manufacturing uses (those not in existence in the coastal zone as of the date of enactment). Expansions of nonconforming manufacturing uses also require permits. An environmental impact statement is required as a part of the permitting process. Permits are granted or denied by the State Planner. Industrial and manufacturing uses not specified in the Act are not controlled under the Act and only local regulations and restrictions apply to such unspecified uses.

New Jersey's Coastal Area Facility Review Act does not place an absolute ban on any facility development, but does provide for a permitting system for specified developments within the coastal zone. Developments covered under the Act include specifically defined manufacturing, processing, storage, housing, and electric generating facilities. An inventory of the characteristics of 1,300 square miles of coastal New Jersey is being completed this fall as required under the Act. A master plan for development and preservation of the coastal area is scheduled to be completed in the fall of 1977, resulting from the studies underway and the development of growth strategies for the area. Impact statements are required as a part of the permitting procedure. The Act is administered by the Department of Environmental Protection.

Maryland's Coastal Facility Review Act, enacted this year, provides for a permitting system for specified developments in coastal counties. Facilities specified are refineries as well as support facilities associated with offshore oil and gas operations. The Act requires a statement of the economic, fiscal, and environmental impacts of proposed facilities. Impact analysis and processing of an application for a permit cannot commence until all local regulations and ordinances have been complied with, unless the locality involved requests the impact analysis before making a decision on the subject application. The Act is administered by the Maryland Department of Natural Resources.

c. Pollution Control

The control of air and water pollution falls under the jurisdiction of both Federal and state laws. New construction, increased sewage loadings, oil discharges, and so on are regulated by various and sometimes overlapping authorities. Permits must be secured to build and operate any facility or dispose of any material that might add to the already existent pollution levels. Offshore as well as onshore facilities are included under the major regulations listed below.

Air

In accordance with the 1970 amendments to the Clean Air Act, all States were required to submit to EPA for approval, implementation plans for achieving the national ambient air quality

standards for the five major pollutants -- particulates, sulfur dioxide, carbon monoxide, nitrogen oxides, and photochemical oxidants -- by the 1975-1977 deadlines. All the states in the Mid-Atlantic region have had their plans approved. Certain areas, in which the existing automobile-related pollution would prevent the achievement of these deadlines in spite of the control devices on stationary emission sources and newer automobiles, were also required to submit transportation plans describing more stringent controls. In this Mid-Atlantic region, New York City and the New Jersey suburbs of New York and Philadelphia submitted such plans and have had these plans approved.

In general, the States' plans for implementation include the five major pollutants and any additional ones they choose, for example, hydrogen sulfide. They specify either the same or more stringent ambient standards than set by EPA for each pollutant. Polluters are required to install control technology or take other steps to achieve and maintain these standards. New plants or existing plants undergoing major modifications are required to meet performance standards by the use of the best demonstrated technology for reducing emissions (CEQ, 1974). EPA has established these types of standards for sewage incinerators, fossil fuel electric generating plants, petroleum refineries and storage tanks, cement plants, and many other air polluting facilities.

EPA has also published rules and regulations regarding the deterioration of air quality in those areas which are presently below the level of the published standards. Limits have been set on the allowable increases of particulate matter and sulfur dioxide in three designated classes. Class I includes areas of restricted growth, such as parks and wildlife areas, and Class II, areas of moderate growth. Class III includes areas in which growth is not restricted as long as the secondary air quality standards are not violated. (See Table II-23 for these standards.)

The allowable increases are listed below:

Pollutant	Class I ($\mu g/m^3$)	Class II ($\mu g/m^3$)
Particulate Matter:		
Annual geometric mean	5	10
24-hr maximum	10	30
Sulfur dioxide:		
Annual arithmetic mean	2	15
24-hr maximum	5	100
3-hr maximum	25	700

At present, all areas in the U.S. are designated as Class II. However, States may submit proposals to EPA to change the designation of any area to Class I or Class III.

Besides the implementation plans, each state also has air pollution control laws and regulations. These include provisions for obtaining a permit to construct any new facility that would add to the

existing pollution load and a permit to operate the facility after completion. There are special stipulations covering open burning, incinerators, coke ovens, fuel oils, and many other sources of air pollution. Emergency plans and procedures are also described. These include the specific concentrations of individual pollutants that qualify as alert, warning, or emergency stages and the types of actions required in each state, for example, reduction in use of high sulfur fuels, curtailment of incinerators, reduction of electricity generated, and so on.

Water

The 1972 amendments to the Federal Water Pollution Control Act require that every "point source" discharger of pollutants obtain a permit which specifies the allowable constitutents and amounts of its effluent (CEQ, 1974). Those with ocean outfalls are required to comply with criteria set out in the Marine Protection, Research and Sanctuaries Act of 1972. This permit program is administered by EPA or by authorized states that have met certain requirements. In this region, Delaware, Maryland, Virginia and New York administer their own permits, while EPA administers permits for New Jersey.

All permits are based on national effluent standards and water quality standards. EPA has published the effluent standards or guidelines along with new source performance standards for most industries and municipal treatment plants. These guidelines were

developed by EPA contract studies along with input from industry and considerations of the economic impacts of the proposed standards on individual industries. The water quality standards are based on the condition of particular stretches of water on which polluters may be located. The states designate these stretches for various uses, for example, recreation, industrial and municipal water supply, or agriculture, and publish criteria for each. If the effluent standards are insufficient for maintaining these uses, stricter controls may be imposed.

The permits also contain a schedule specifying dates by which the discharger has to achieve compliance. At present, the years 1977 and 1983 are the important deadlines for compliance for both effluent and water quality standards. By 1977, municipal sewage treatment plants must have secondary treatment and all industrial sources must have the best practicable control technology for their class and type of discharge. By 1983, the municipal plants must have the best practicable treatment and industry the best available technology economically feasible. For water quality standards, the Act's objective has been interpreted to mean the restoration and maintenance of the chemical, physical, and biological integrity of the nation's water. This implies that standards will protect the indigenous life and permit secondary contact recreation, such as fishing and boating by 1977. The 1983 goal is to provide for the protection and maintenance of fish and wildlife and for recreation in and on the

water. All offshore and induced onshore facilities that may result from the proposed sale will fall under these stipulations and into these timeframes.

Individual states also have their own water pollution control laws. These laws cover the discharge of sewage, oil, and other hazardous materials and specify restrictions for protecting groundwater supplies. They require permits to build and operate facilities that discharge waste into state regulated waters and establish fines and libability provisions for various offenses. They also stipulate in their oil spill contingency plans that all spills must be reported and that the cleanup be financed by the responsible party.

With regard to oil spills, there are also Spill Prevention Control and Countermeasure Plans (SPCC) required by Federal law for all state, local, and Federal installations that have oil transfer or storage facilities. These plans specify actions taken to prevent spills, such as dikes and other secondary containment hardware, and must be certified by a professional engineer as representing good engineering practices. EPA can inspect these facilities and assess fines for inadequate measures. In addition, a Coast Guard operations manual is required for all large oil transfer facilities, i.e. those transferring oil to or from a vessel with a capacity of 250 barrels or greater.

More attention has recently been focused on nonpoint sources of water pollution. These are now recognized as a major source of pollution that sometimes account for a greater percentage of the

waste loads than do point sources. They include groundwater leachate, airborne precipitates, and the runoff from agricultural lands, construction sites, beaches and suburban areas. EPA has published guidelines for controlling some of these sources, but at present, regulatory authority rests with the state and local governments.

d. Other Planning Mechanisms

Both New York and New Jersey have enabling legislation which grants zoning and subdivision authorities to municipal governments. While counties in both states have planning agencies and programs, administrative and implementation measures are the responsibility of local governments.

New York is divided into state-planning districts. These districts function extensively as regional districts for state-administered programs. One regional planning agency, the bi-county Nassau-Suffolk Regional Planning Commission, plays an active and strong role in the planning process of these two Long Island counties.

The New York Department of State, Division of State Planning provides technical and funding aid to local governments in their development of planning programs. It also acts as the principal state agency in developing and administering funds for the state coastal zone management program.

New Jersey does not have planning districts as New York does. Planning services to New Jersey counties and municipalities are provided by the Department of Community Affairs.

Nine New Jersey counties, the City of New York, seven other New York counties, as well as counties in Connecticut, are included in the Tri-State Regional Planning Commission, an active interstate planning commission which deals with the New York City metropolitan area.

Camden, Burlington, Mercer, and Gloucester Counties are members of the Delaware Valley Regional Planning Commission, along with five Pennsylvania counties in the Philadelphia metropolitan area.

Maryland, Delaware, and Virginia all have enabling legislation which, aside from granting zoning and subdivision ordinancing authority to municipalities, allows counties to zone and control unincorporated areas.

In Delaware, counties serve as the regional planning bodies. New Castle County has had an active planning program since the 1930's, while Kent and Sussex Counties have had planning programs only since the late 1960's. All coastal localities have zoning ordinances. New Castle County is a participant in the Wilmington Metropolitan Area Planning Commission (WILMAPCO).

The Delaware State Planning Office, in addition to providing planning assistance to localities, also has state-planning functions. It is the primary agency responsible for developing a coastal zone management plan for the state, and it has developed a preliminary state development plan.

All counties in Maryland have planning commissions and most have comprehensive plans which are at least partially adopted, as well as zoning and subdivision ordinances. The Baltimore Regional Council is also active in planning functions. Another established regional agency is the Maryland National Capitol Parks and Planning Commission, which includes Prince Georges and Montgomery Counties. The counties in the District of Columbia area also participate in the Metropolitan Council of Governments. The Tri-County area in southern Maryland, as well as the eastern shore, is working on developing planning programs certifiable by the Department of Housing and Urban Development (HUD) for planning purposes for HUD grants.

The Maryland Department of State Planning serves as a technical assistance and funding agency for county and local governments, as well as for state-planning functions. It is presently conducting studies and inventories in the process of developing a statewide plan.

While enabling legislation provides Virginia counties and municipalities with zoning and planning authorities, not all Virginia

counties or municipalities have planning commissions or ordinances. All independent cities in the Norfolk area do have zoning and subdivision ordinances, however. On the eastern shore, Accomack County has no such ordinances, while Northampton County does. However, few municipalities on the eastern shore have any zoning or subdivision ordinances.

Virginia is divided into planning districts which, while they must develop comprehensive plans, have only an advisory role to the local governments in the areas they encompass. The Division of State Planning and Community Affairs is the State agency which provides planning assistance to local governments and planning districts, and acts as the principal State agency responsible for the development of the State coastal zone management plan.

Virginia counties and independent cities in the Washington, D.C., metropolitan area participate in the area's Metropolitan Council of Governments.

The siting of any onshore OCS-related facilities in the Mid-Atlantic area would be subject to the planning mechanisms and controls discussed above.

Federal-interstate commissions with some planning functions in the region are the Delaware River Basin Commission, in which New Jersey, New York, Pennsylvania, and Delaware participate, and the New England River Basin Commission which includes New York.

II. DESCRIPTION OF THE ENVIRONMENT

This section presents a description of those facets of the natural and socio-economic environment which could be impacted by activities resulting from this proposal and those which could significantly affect the activities resulting from the proposal. The accompanying set of Visuals (Volume 4) illustrates the location of the tracts proposed for leasing in relationship to certain facets of the environment of the Mid-Atlantic.

Section D.2. in the preceding Section discusses elements of the environmental baseline studies which may provide information to fill or partially fill data gaps identified in the discussion below.

A. Geological Framework

1. Introduction

The Atlantic Continental Shelf represents a natural seaward extension of the onshore Atlantic Coastal Plain, a gently sloping cover of Mesozoic[1] and Cenozoic sedimentary strata stretching from southern New England to southern Florida. These Coastal Plain sediments are deposited over metamorphosed Precambrian, Paleozoic, and mostly unmetamorphosed Triassic rocks (Owens and Sohl, 1969) of the Piedmont and New England Maritime Province (Thornbury, 1965).

[1]Table II-1 illustrates time-stratigraphic relationships.

AGE DIVISIONS			TIME			
ERA	PERIOD	EPOCH	DURATION IN MILLIONS OF YEARS ERA	PERIOD	EPOCH	BEGINNING MILLIONS OF YEARS AGO
CENOZOIC	QUATERNARY	RECENT	70.011	1.011	0.011	0.011
		PLEISTOCENE			1	1
	TERTIARY	PLIOCENE		69	9	10
		MIOCENE			15	25
		OLIGOCENE			15	40
		EOCENE			20	60
		PALEOCENE			10	70
MESOZOIC	CRETACEOUS		160	60		130
	JURASSIC			50		180
	TRIASSIC			50		230
PALEOZOIC	PERMIAN		370	40		270
	PENNSYLVANIAN			64		334
	MISSISSIPPIAN			16		350
	DEVONIAN			50		400
	SILURIAN			40		440
	ORDOVICIAN			60		500
	CAMBRIAN			100		600
PRE-CAMBRIAN	GRENVILLE OROGENY		4000			1000
	OLDEST KNOWN ROCKS IN NORTH AMERICA					3200
	OLDEST KNOWN ROCKS (MURMANSK AREA)					3400
	PROBABLE AGE OF THE EARTH					4600

Table II-1. Geologic Time Chart. From data in Braziunas, T. 1975. A geological duration chart, Geology, 3(6): 342-343.

Offshore, the Continental Shelf, Slope, and Rise comprise the Atlantic continental margin of North America. Width of the Shelf ranges from approximately 200 km (125 miles) off northern New Jersey to 125 km (78 miles) off Cape Charles. The relatively smooth, gently-sloping shelf extends seaward to a water depth of 100 to 200 meters; a break at this depth marks the beginning of the more steeply inclined Continental Slope. A number of submarine canyons have been cut along the shelf/slope boundary. At the foot of the slope, regional declivity decreases onto the Continental Rise which slowly descends from a water depth of 2000-3000 meters to oceanic basin depths exceeding 5000 meters.

2. Baltimore Canyon Trough and Potential Producing Horizons[1]

The Baltimore Canyon Trough is approximately 500 km (300 miles) long, extending south from offshore of Long Island to the vicinity of Cape Hatteras, and is about 200 km (125 miles) wide at its widest location off southern New Jersey. Water depths over it range from 6 to 1800 meters (20 to 6000 ft), though over its axis, which lies approximately 100 km (60 miles) offshore, depths

[1]Although the Department of Interior has obtained copies of all geophysical data collected by the petroleum industry and had complete access to the recently completed stratigraphic test well in the Baltimore Canyon Trough that information is considered proprietary and thus, unavailable for public distribution. This section of the EIS and others which follow contain as much information as is publicly available.

are mostly 60 meters (200 ft). These figures represent the dimensions of the entire Trough and not of the smaller proposed lease sale area.

Drake et al. (1959) and later authors, such as Kraft et al. (1971), Maher (1971), Emery and Uchupi (1972), Mattick et al. (1974), Sheridan (1974a, 1974b), Schlee et al. (1975), and the USGS (1975) have summarized existing data and helped to develop a conceptual framework to describe the structure and petroleum potential of the Mid-Atlantic continental margin. In general, it is believed that during the initial opening of the Atlantic Ocean, either during the Permian (Emery et al., 1970) or Triassic (Hallam, 1971), the European and American continental plates were subjected to tensional forces. These forces may have provided the mechanism for the downdropping of the large fault block which became the Baltimore Canyon Trough.[1] Further depression of the trough probably occurred due to the weight of an accumulating sediment load.

Interpretation of geophysical data has led to the postulation of a "basement ridge" paralleling the slope/shelf boundary. It is believed that the ridge was uplifted during the Jurassic to become a barrier and consequently restricted the flow of sea water. Behind the ridge

[1]Named by Maher (1965) for the large submarine canyon which occurs at the location where the trough intersects the edge of the Continental Shelf.

an evaporate basin may have formed and anhydrite, dolomite, and limestone were possibly deposited. Upward movement along the ridge may have slowed or stopped during the late Cretaceous and sediments overflowed the trough onto the Continental Slope and Rise. Exposure of the ridge in the Jurassic and Cretaceous may have provided an opportunity for the development of fringing, patch, or platform reefs.

Lithologies of Mesozoic and Cenozoic rocks within the trough are derived through analysis of seismic velocity data (U.S. Geological Survey, 1975) and grab samples or cores from the Continental Slope (Weed et al., 1974). Figure II-1 indicates sediment thickness of the entire trough.

The Jurassic may contain a thick section of prospective calcareous rocks (limestone, dolomite, anhydrite), but its top may be at 7000 m (23,000 ft) beneath the axis of the trough. Therefore, it is considered too deep for economic exploitation at this time.

Lower Cretaceous sediments represent the best prospect for petroleum in the Baltimore Canyon Trough. Rapid sedimentation in marine conditions might have allowed the accumulation of organic materials necessary for petroleum occurrence. Upper Cretaceous sediments are most likely marine sands, shales, and calcareous rocks; more shales are thought to be present in the Upper than Lower Cretaceous, hence it may contain fewer reservoir rocks though it is still considered

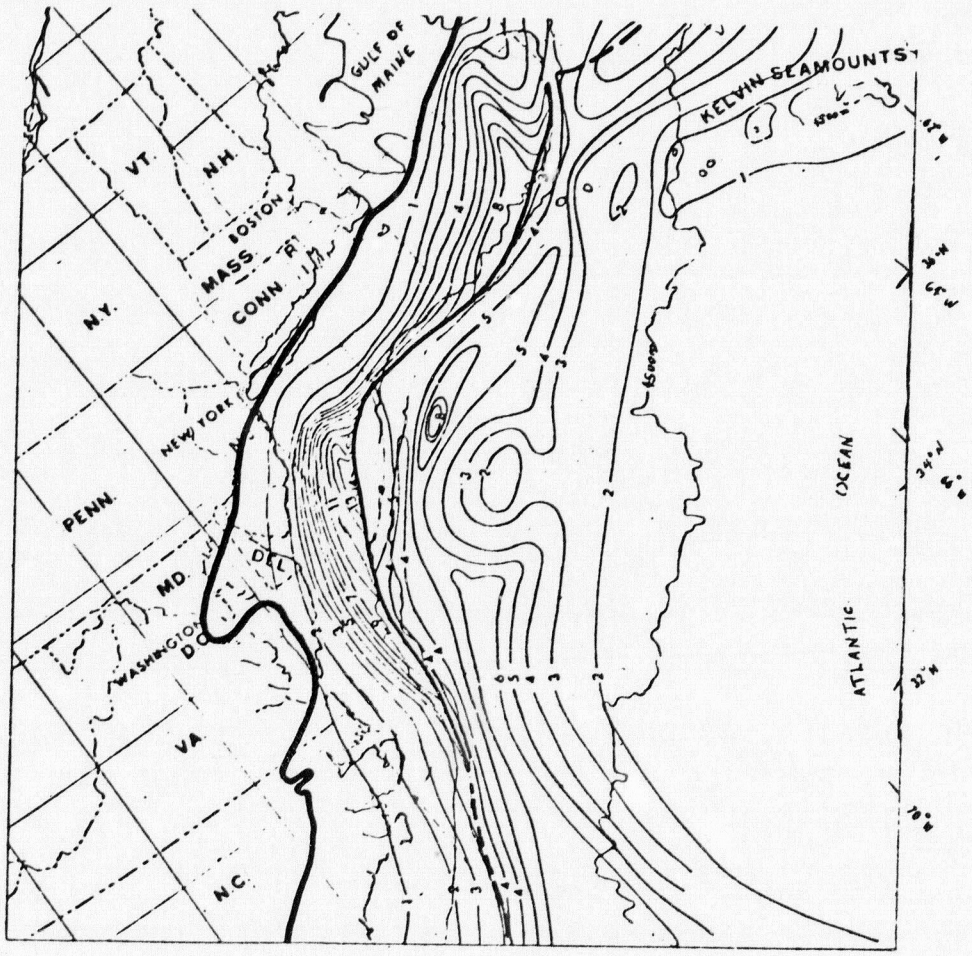


Figure II-1. Interpretive Map of Atlantic Continental Margin Showing Thickness of Sediments (Modified from U.S. Geological Survey, 1975)

prospective. Total thickness of the Cretaceous is estimated at 5250 m (15,000 ft) in the center of the trough.

A potential source bed was identified by the Deep Sea Drilling Program (Hollister et al., 1972) in a core obtained from the Continental Slope southeast of New York. Over 100 m (328 ft) of dark green to black Mesozoic clays, containing large amounts of organic material, were found. It is not known if this or similar beds extend to the Shelf, but the possibility does exist.

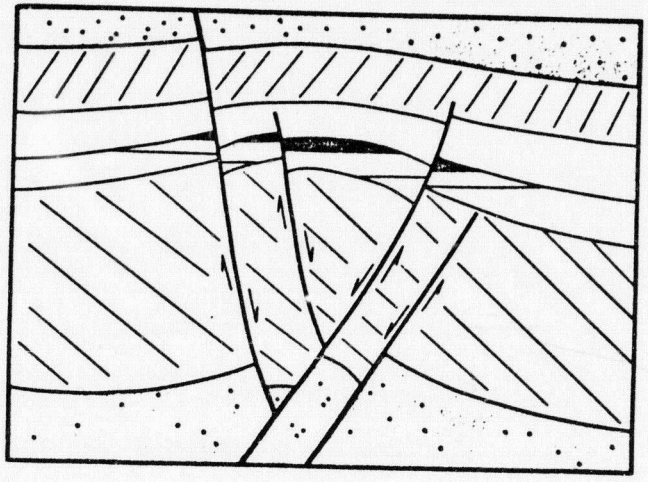
The Tertiary section offshore is believed to be too thin (2100 m to 6000 ft) and contain too few structural anomalies to be highly prospective (USGS, 1975).

It is expected that trapping mechanisms for petroleum in the Mid-Atlantic area will fall into the following categories: 1) structural relief over intrusions, fault blocks, and possible reefs; 2) possible reefs; 3) fault traps; and 4) stratigraphic traps (USGS, 1975; Oil and Gas Journal, 1976).

Requirements for economically attractive accumulations of gas and oil are source rock (strata which provide organic matter subsequently transformed into fluid hydrocarbons), reservoir rock (porous and permeable strata into which the hydrocarbons migrate and can eventually be pumped out of), and traps (impermeable rock barriers to migration which allow significant hydrocarbon accumulations to develop).

A structural trap is one whose upper boundary has been made concave, as viewed from below, by some kind of local deformation such as folding, or faulting, or both. A stratigraphic trap is one in which the chief trapping element is some variation in the stratigraphy or lithology (reefs are excellent stratigraphic traps). Combination traps are traps formed by combinations of stratigraphics and structural elements. Figure II-2 illustrates some of the kinds of traps which might be found in the Mid-Atlantic.

Figure II-3 illustrates the major features interpreted from one of 13 publicly available seismic profiles shot on the Atlantic OCS and obtained by the U.S. Geological Survey, Geologic Divison. Shown on this figure is a large basement intrusion (igneous?) which has uplifted Jurassic and Lower Cretaceous rocks several thousand meters. In addition, overlying Upper Cretaceous and Tertiary beds have as much as 500 m (1600 ft) of relief which apparently was



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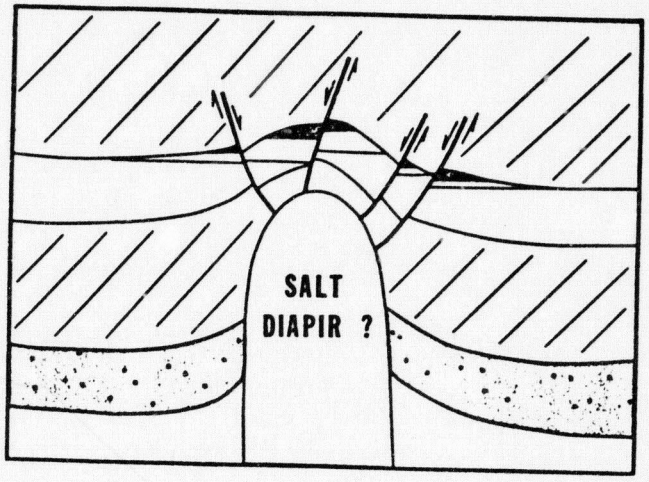
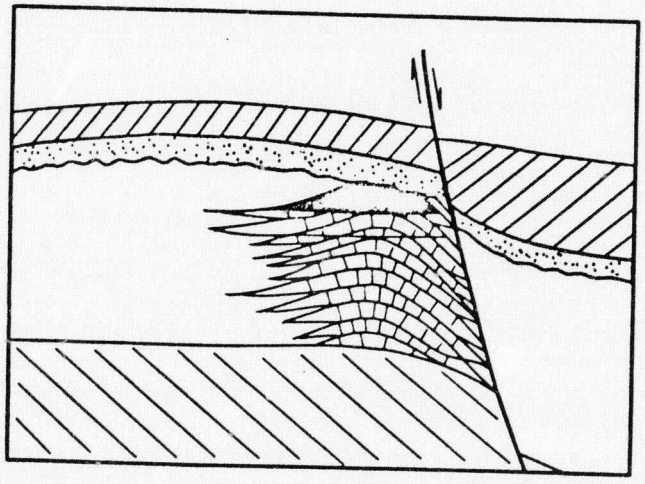
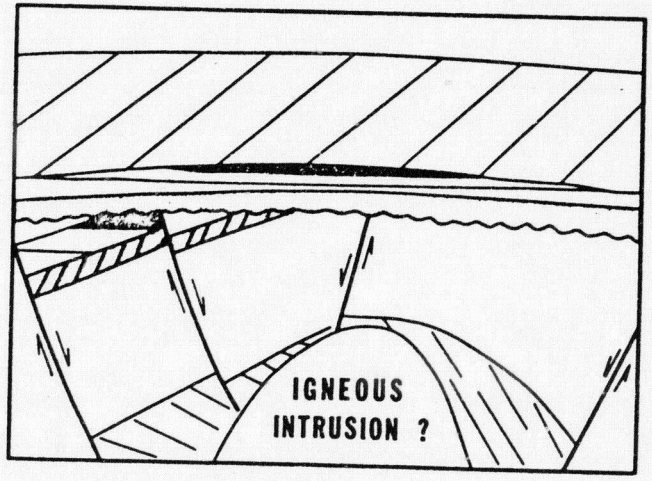


DIAPIRIC STRUCTURE



STRATIGRAPHIC



STRUCTURAL STRATIGRAPHIC
COMBINATION

Figure II-2. Potential Trap Types in the Mid-Atlantic Outer Continental Shelf. (Taken from John L. Loftis, Jr., public hearing testimony, DEIS proposed OCS Lease Sale #40, 1976)

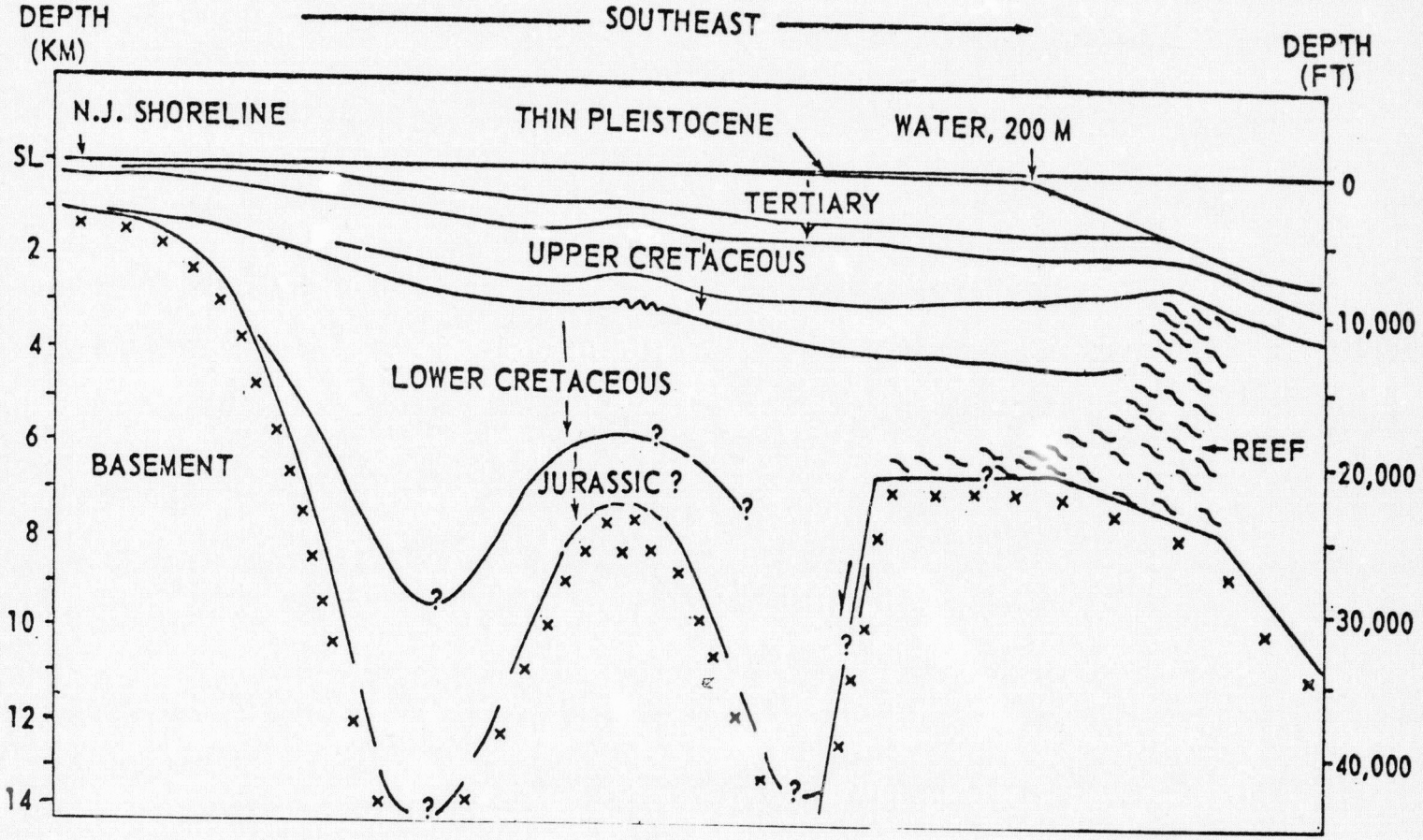


Figure II-3. Diagrammatic Section Across Baltimore Canyon Trough Illustrating Regional Structures and the General Geology. Figure is based on a common depth point seismic reflection profile shot for the U.S. Geological Survey offshore of New Jersey. The basement intrusion located near the center of the diagram is a local feature in the Baltimore Canyon trough. The ridge structure beneath the shelf-slope break parallels the Continental Slope along the entire Mid-Atlantic area. From USGS (1975).

caused by draping or differential compaction of the overlaying material. As of this writing, three smaller intrusions have been identified in the trough. The USGS (1975) located one west of the igneous intrusion and one directly south of the intrusion.[1] Sheridan (1975) has observed arching in Tertiary sediments offshore of Delaware which may have been caused by emplacement of either an igneous intrusion, reef, or a shale or salt diapir at depth. The locations of these structures are shown on Visual No. 3. Studies required by the USGS prior to drilling of the recent Cooperative Offshore Stratigraphic Test (COST) well (in tract 540 of Protraction Diagram NJ-3) revealed the presence of a gentle upwarping that may indicate a larger domal feature at greater depth.[2]

Preliminary examination of other publicly available geophysical data indicates the presence of a possible Cretaceous reef (USGS, 1975) overlying the basement ridge beneath the Continental Slope.

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1 R. E. Sheridan, University of Delaware, and J. Grow, USGS, Woods Hole, Mass., personal communication, 1975.

2 From report by BBN Geomarine Services Company, 1975: COST Well Site B-2, Baltimore Canyon Engineering Geology Interpretation of High Resolution Geophysical Data.

It is possible that source rocks beneath the Slope and Rise may have yielded petroleum which subsequently became trapped in the porous reef.

Well data from the Coastal Plain indicates that there is a general tendency for Lower Cretaceous and Jurassic sediments to pinch out in the updip direction. Although difficult to locate, these stratigraphic traps could contain substantial petroleum deposits. Several hundred wells have been drilled onshore with nc finds of oil and gas, but these stratigraphic traps could be present under State waters (particularly off New Jersey and Delaware where sediment thickness begins to increase rapidly) or the Federal OCS between the end of State jurisdiction and the present proposed lease areas.

To date, no production has taken place on the Atlantic Coastal Plain or Outer Continental Shelf but discoveries have been made on Canada's Scotian Shelf. On the Scotian Shelf, 56 wells have been drilled and 10 are temporarily shut in.[1] Thick pay zones are centered over salt domes (Smith, 1975) in arched and faulted Cretaceous and Jurassic sandstones.

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[1] D. Whitehead, Canada Department of Energy, Mines, and Resources, personal communication, 1976.

Although this may represent the nearest analog to the Baltimore Canyon trough in terms of location on an Atlantic type continental margin, natural variability of the sedimentary section makes it extremely difficult to extrapolate from one field to another, let alone one basin to another. Hence, no statement can be made about the type of production which might be expected in the Baltimore Canyon Trough (oil prone or gas prone, or kind of crude oil).

3. Surficial Shelf Sediments and Shallow Structures

The present surficial morphology of the Continental Shelf reflects events which occurred predominantly during the Pleistocene and Holocene (Recent). Believed to underlie Quaternary sediments on the shelf are Tertiary and Cretaceous sands, silts, clays, limestones, and shales. The Army Corps of Engineers' Coastal Engineering Research Center in its Inner Continental Shelf Sediment Program[1] has described the Cenozoic section nearshore in the Mid-Atlantic as identified from subbottom profiles and shallow cores. Meanwhile, Weed et al. (1974) reported the composition of pre-Pleistocene rock samples taken from cores and grabs along the Continental Slope. No detailed stratigraphic record presently exists for the Tertiary of the Outer Continental Shelf other than by inference from that data, Coastal Plain wells, or geophysical data.

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[1] See Bibilography.

During the Pleistocene, major marine regressions took place. At that time, the surface of the Continental Shelf down to at least what is now covered by 120 m (394 ft) of water may have been exposed land (Emery and Milliman, 1971). The basis for this is carbon-14 dating of various materials and the finds of terrestrial vertebrate fossils on the OCS (Figure II-4). Because of this dating technique, the best record of Pleistocene glaciations exists for the last one which began some 30,000 years B.P. (before present) according to Milliman (1974). Sea level fell slowly until 21,000 years B.P. when it fell more rapidly, reaching its lowest stage 15,000 years B.P. At that time a glacial ice sheet covered all of New England, part of Georges Bank, most of Long Island, and half of New Jersey (from a diagram by Schlee and Pratt, 1970, page 28). With the melting of the glaciers, sea level rose rapidly until 5000 years B.P. when the rate slowed to approximately 2m/1000 years (Milliman, 1974).

As a result of the lowering of sea level, many rivers incised their channels into the Continental Shelf and Slope, giving rise to the large number of submarine canyons north of Cape Hatteras (Emery and Uchupi, 1972) or deposition of small deltas on the

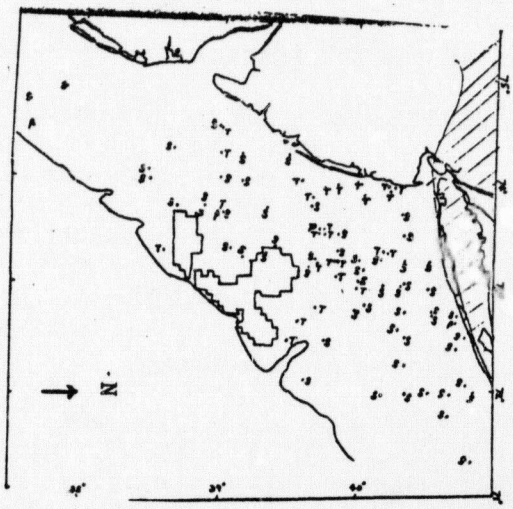

Figure II-4. Locations of Indicators of Low Strands of Sea Level on the Continental Shelf. (T) stands for elephant teeth, (P) for peat, and (S) for shallow-marine mollusk shells. Diagonally lined area is limit of southern movement of glacial ice sheet. (Modified from Emery and Milliman, 1971 and written testimony of Emery, Public Hearing, DEIS OCS Sale #40, 1976)

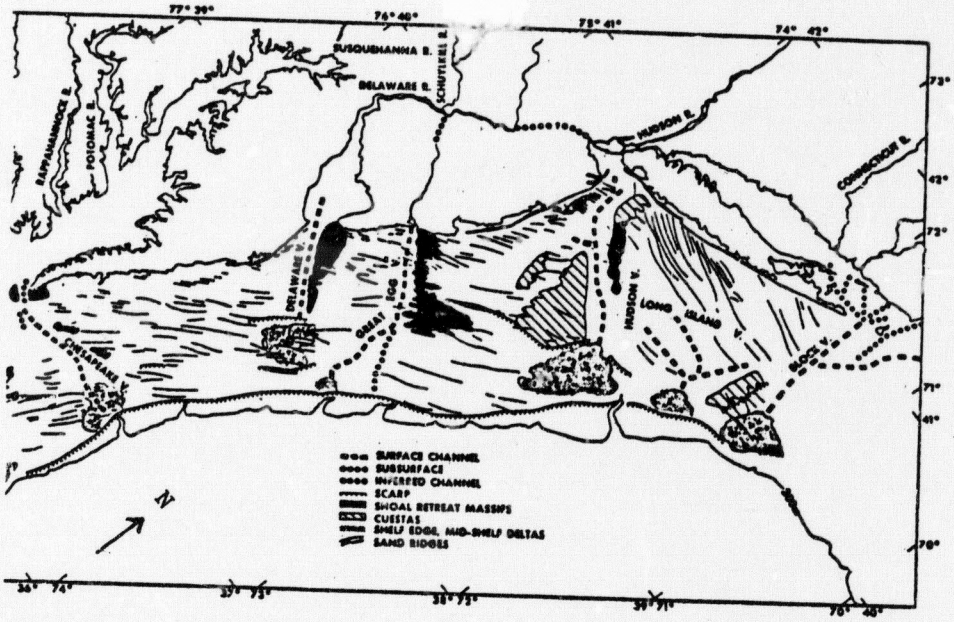

Figure II-5. Morphology of the Mid-Atlantic Continental Shelf (Modified from Swift, in press)

Shelf. The subsequent marine transgression is the key to the present configuration of the Continental Shelf; Swift et al. (1972), Swift et al. (1973), and Swift and Sears (1974) have outlined much of the present thought[1] of this matter.

When the shoreline began its retreat due to increasing water height, estuaries migrated back across the shelf leaving behind valleys still discernible today on bathymetric charts: the Hudson, Great Egg, Delaware, and Chesapeake. In some cases (Great Egg and Chesapeake shelf valleys) they did not follow the original channel routes and those routes are buried beneath Pleistocene and Holocene sediment (Figure II-5). The valleys themselves have been infilled with sediment, coming from deposits called "shoal retreat massifs" located just north of the valleys. Shoal retreat massifs are large-scale topographic highs which have appreciable relief and are composed of small-scale features like sand ridges; it is believed that massifs are coastal shoals extending across the shelf along their retreat paths from rising sea level. Smaller buried channels[2] are to be found along the entire Mid-Atlantic coast and are illustrated on Visual 3.

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1 A more complete list of references is included in the Bibliography.

2 Locations provided in Williams and Duane (1974), Alpine Geophysical (1974), Williams (1975), and Field (1975).

A surficial sand sheet is present between the shelf valleys, and it ranges in thickness from 0 to 20 m (66 ft). This is due to the development of the ridge and swale (or linear shoal) topography which is a characteristic of the Mid-Atlantic continental margin: fields of ridges 2-4 km apart with heights up to 10 m which extend for tens of kilometers (Visual No. 3). Crests and trough axes climb southwest across the shelf and converge with the shoreline. Data indicate that the ridges are less than 11,000 years old[1] and rest on slightly older lagoon deposits of Holocene age or Pleistocene sediments.[2] Earliest interpretations of this topography suggested that relict strand plains were acted on by the marine transgression to form ridges during stillstands or that some nearshore ridges were former beach ridges. However, it is now believed that the ridges and shoals are bedforms formed in response to intermittent storm currents. Along the Delmarva coast,[3] ridges formed on the shore face may have become detached during coastal retreat to form fields of isolated ridges (Figure II-7).

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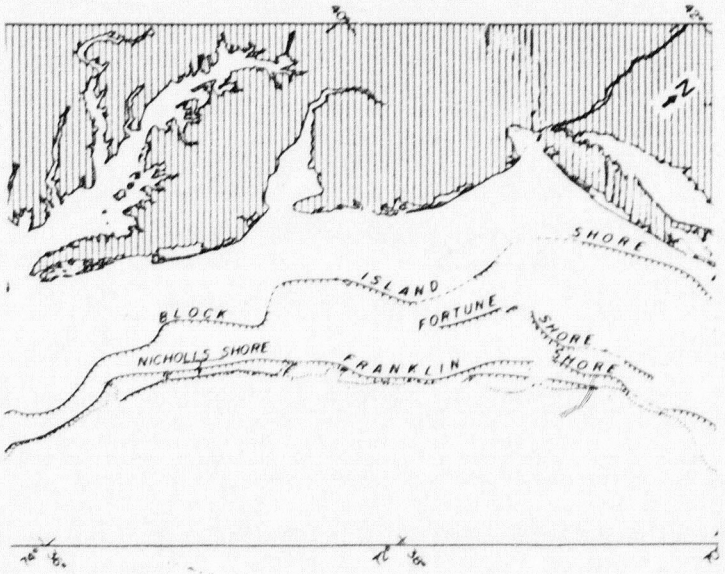
1 The USGS in part of the BLM environmental studies program, has obtained a radiocarbon date of 9310 years B.P., from shell material incorporated within sand waves near Wilmington Canyon.

2 An age date of 32,730 years B.P. was recently obtained by Field (1975) for those underlying sediments off Ocean City, Maryland.

3 Figure II-8 illustrates the ridge field in this area.



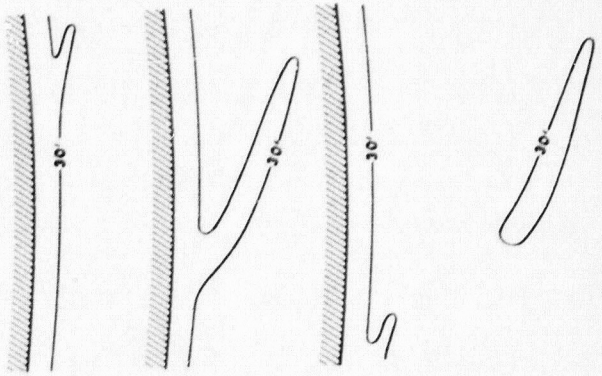


Figure II-6 . (Above Left) Approximate Location of Nicholls, Franklin, Fortune, and Block Island Shorelines. (Modified from Milliman, 1974)

Figure II- 7. (Above Right) Schematic Model for Evolution of Shoreface-Connected Ridge into Isolated Shelf Ridge during Transgression. Headward extension and axial deepening of trough intensifies rip-like current which sweeps over ridge base, cutting saddle, and eventually isolating ridge. Shoreline retreats and ridges migrate down-coast and offshore. (From Swift et al., 1973)

Figure II- 8. (Below Right) Shoreface-Connected Ridge Field of the Delmarva Coast. Dashed lines are crest lines. (From Swift et al., 1973)

Recent geophysical studies conducted by the USGS Marine Geology Branch as part of the BLM environmental studies program have found that:[1]

> Bottom topography is generally smooth, with local relief seldom exceeding 3 m. Greater relief occasionally resulted from probable sand waves (3-5 m high) and rarely from larger features (15-20 m), which may represent drowned barrier islands.
>
> Sub-bottom reflectors are quite continuous beneath the outer 40-50 km of the shelf to the north of Cape Henlopen, whereas to the south reflectors are more discontinuous, averaging 5-10 km in length. Reflectors are more continuous in the cross-shelf direction than along shelf. Several apparent unconformities occur within the upper few tens of meters beneath the shelf surface. The unconformities, of probable Pleistocene age, are characterized by extensive channeling, with the larger channels (7-25 m in depth) more common to the south of the Hudson Channel. Large buried valleys are most common off the northern Virginia Coast. Conversely, reflectors representing beds are smoother to the south of Delaware Bay, whereas to the north, greater irregularities appear as the position of the Pleistocene ice front is approached.

Erosional scarps and terraces (sometimes collectively called "cuestas") found across the Atlantic OCS indicate the locations of former marine stillstands. Veatch and Smith (1939) using bathymetric data located a surface they named the Nicholls shoreline at 149 m (460 ft), the Franklin shoreline at 100 m (328 ft), the Fortune shoreline at 65 m (214 ft), and Block Island shoreline at

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[1] From preliminary, unpublished "Mid-Atlantic OCS Environmental Assessment, 2nd Quarterly Report for Period 30 September - 31 December, 1975," USGS, Marine Geology Branch, Woods Hole, Massachusetts.

40 m (131 ft) offshore of New York (Figure II-6). These shorelines become much shallower to the north and somewhat less to the south. Offshore of Cape Hatteras these features are located in less than 50 m (163 ft) water depth. The Nicholls is found onshore in southern Maine and the Fortune disappears south of New Jersey (Emery and Uchupi, 1972).

Variations in sediment texture are reported for the shelf[1] as a consequence of local hydraulic regime, sediment availability, and composition, but in general the following statements do basically hold true for the Mid-Atlantic. Surficial sediments on the Shelf are primarily well sorted sands composed of quartz and feldspar. Gravel or gravel/sand deposits are located in various areas on the shelf outside the proposed sale area (Visual No. 3), though by far the largest lies south of the Hudson shelf valley; Schlee (1972) believed that this deposit was put down by rivers during the Pleistocene and subsequently reworked by marine waves and currents. It is also possible that the deposit may be related to the ancestral Delaware River drainage (State of New Jersey, Written Comments, DES for Proposed OCS Lease

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1 Some important papers include: Ross (1970), Schlee and Pratt (1970), Swift et al, (1972), Milliman (1972), Emery and Uchupi (1972), Trumball (1972), Schlee (1973), Frank and Friedman (1973), Hollister (1973), Swift et al.(1973), and Stubblefield et al. (1975).

Sale #40, 1976). Glauconite content of the sands increases towards shore, the result of erosion of Coastal Plain sediments. Silts and clays are the predominant sediment type on the Continental Slope and Rise.

Ocean Mining of Sand and Gravel

Although no ocean mining on the Atlantic OCS is presently taking place, interest has been expressed towards the possibility of sand and gravel mining in the near future. Sand deposits which could be used for beach replenishment and hurricane protection have been identified offshore of Long Island (Williams, 1975), New Jersey (Duane, 1969), and Virginia (Meisberger, 1972). Nearshore deposits in State waters are currently being mined for this purpose. Due to the presence of the ubiquitous sand sheet in the Mid-Atlantic Shelf, any number of offshore shoals, ridges, or areas could be potential locations for future ocean mining. The gravel and gravel/sand deposits mentioned above could provide materials for the construction industry and land fill.

4. Uplands

This section will broadly outline the geographic setting, surficial geology, soils, and geohydrology of the Mid-Atlantic Coastal Plain and adjacent physiographic provinces.

a. Generalized Geology and Physiography

Figure II-9 shows a generalized cross section of the Mid-Atlantic region from Cape Hatteras to Long Island. Major structural elements which controlled deposition onshore are the Raritan Embayment, South New Jersey High, Salisbury Embayment, and Norfolk Arch (Maher, 1971). The locations are shown on Figures II-10a and 10b.

Long Island[1] is oriented east-west, separated from the New England coast by Long Island Sound and bounded on the east by Block Island Sound. Two Pleistocene moraines are superimposed on the western part of Long Island and diverge further east. They form two peninsulas separated by the Peconic Bays and Gardiners Bay which are shallow brackish water bodies. Topographic relief is greatest on the north shore of Long Island, where to the west cliffs are formed in the Harbor Hill moraine and pocket beaches are common, and to the east where ten recessed bays or estuaries are restricted at their southern ends by the moraine. Along the southern shore is a chain of sandy barrier islands, separated from the mainland by lagoons and broken by six inlets.

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[1] Information in this section on the geology and physiography of Long Island was derived from Williams (1975).

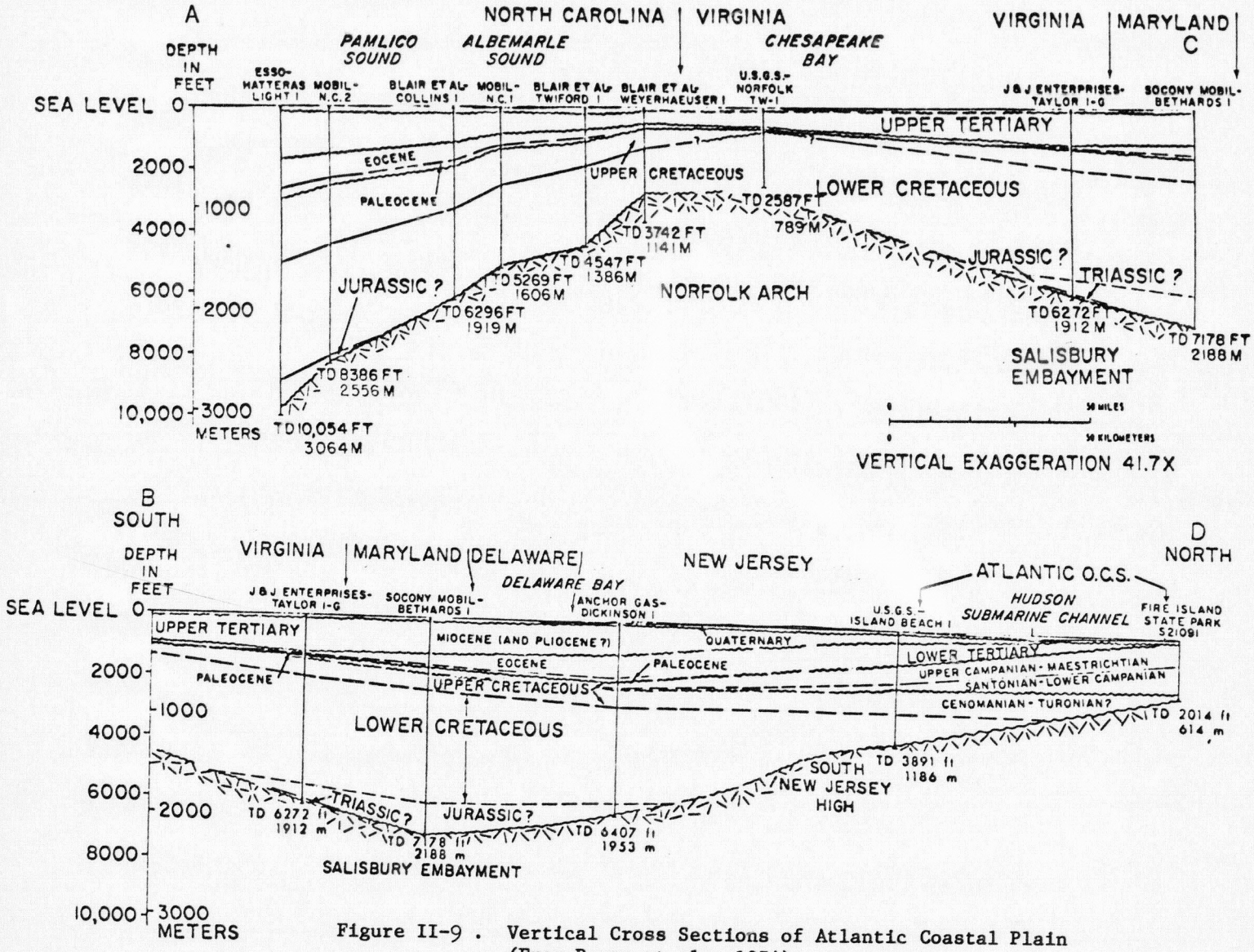


Figure II-9 . Vertical Cross Sections of Atlantic Coastal Plain (From Perry et al., 1974).
Figure II-10 a illustrates well locations.

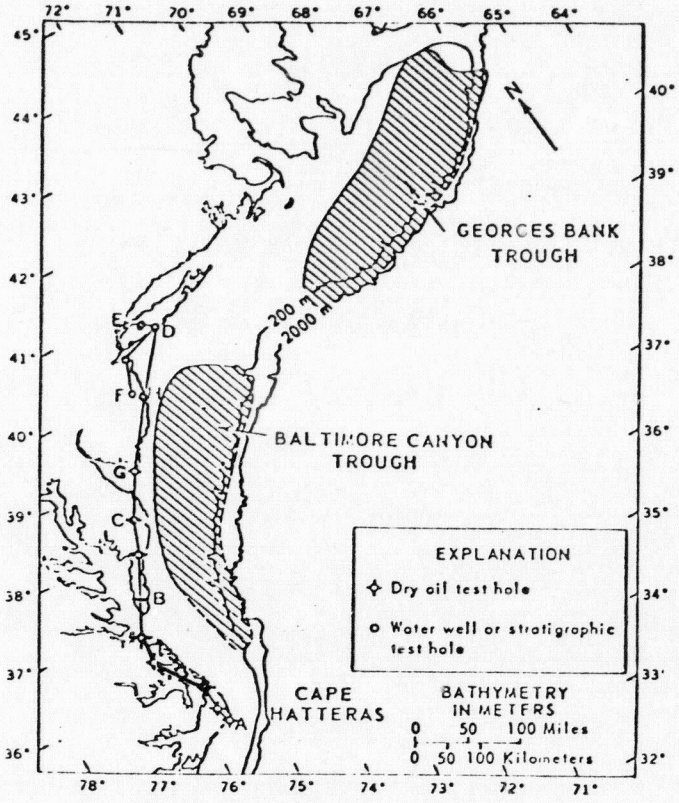


Figure II-10a. Location of Baltimore Canyon Trough and Georges Bank Trough Plus Deep Wells Used for Cross Sections (Figure II-9) (From Perry et al., 1974)

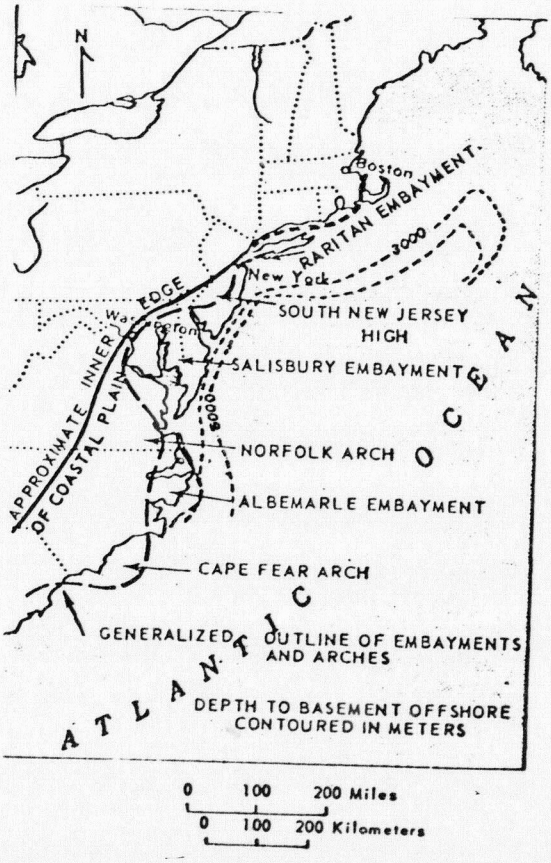
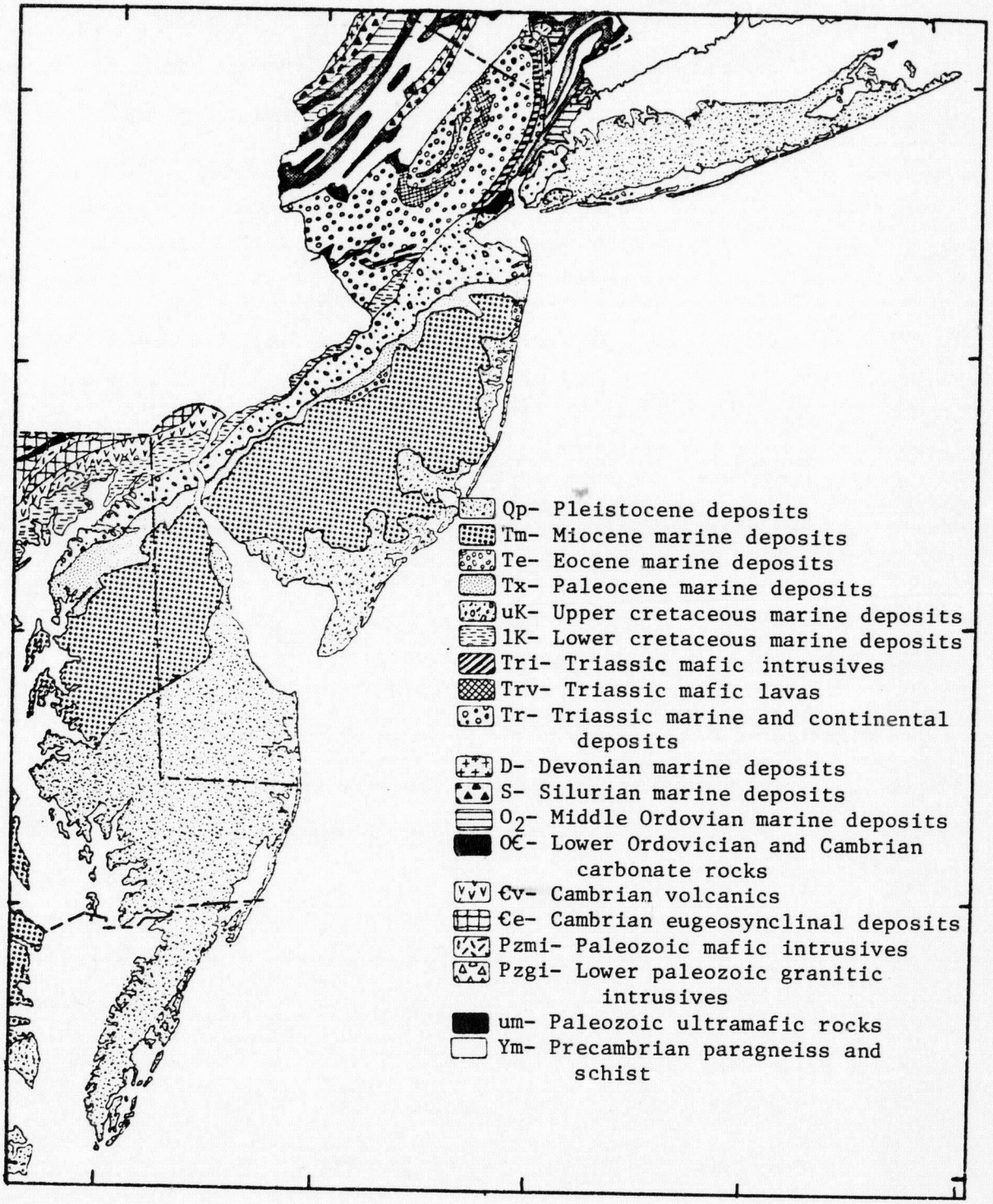


Figure II-10b. Location of Basement Structural Features Mentioned in the Text (From Owens, 1970)

Most of Long Island's surficial geology is related to outwash from Pleistocene glaciation. However, exposures of the Upper Cretaceous clastic sediments are found in some locations along the north shore. Other formations with surface occurrence are either of Tertiary or Quaternary age.

Situated northwest between Long Island and New Jersey is Manhattan Island. New York City has surface exposures of metamorphosed Paleozoic rocks interspersed with Pleistocene glacial detritus. The Paleozoic rocks are part of the Manhattan prong of the Appalachian Highlands. Staten Island in turn lies southwest of Manhattan Island. It is overlain by glacial detritus along the eastern half and has exposures of Paleozoic serpentine, Triassic intrusive diabase, and uppermost Cretaceous sediments.

Across the Hudson River, in New Jersey, are the slightly higher elevations associated with Triassic intrusives (such as the Palisades sill) and the Triassic lowlands beyond and to the west which are found in much of central New Jersey and part of Pennsylvania (Figure II-11). A belt of Precambrian and Cambrian metamorphic and igneous rocks extends across New Jersey creating an area of topographic highlands (elevations up to 460 m - 1500 ft) with intervening valleys. North of the highlands in northern New Jersey and Pennsylvania are Paleozoic rocks which have been eroded into the Ridge and Valley Province which has lower relief than the Highlands.



GEOLOGY OF THE MID ATLANTIC STATES

Figure II-11. (From Geological Map of North America, 1974)

Belts of successively younger sediments (mostly unconsolidated) are located to the southeast of the Highlands and down through the Delmarva Peninsula (Cretaceous, Tertiary, and Quaternary, Figure II-12).

Major topographic features of the New Jersey Coastal Plain include a cuesta built on the Upper Cretaceous, the Great Swamp in south central New Jersey, and the low lying Pine Barrens covering much of southeastern New Jersey.

With the exception of the Sandy Hook spit and the barrier island-lagoon-marsh complex off the central New Jersey coast, much of the New Jersey Atlantic coastline consists of beaches backed by extensive salt or brackish marshes. Major estuaries along the coast include Raritan Bay, Great Bay, and Delaware Bay. From the northwestern part of the Cape May Peninsula to the vicinity of Alloways Creek in Salem County, the coastline is almost entirely marshland. From Alloways Creek north along the Delaware River, marshes are rarely present.

Across the river, from Philadelphia to Brandywine Creek and the Christina River, the channel of the Delaware River is cut into the Precambrian and Paleozoic rocks of the Piedmont Province. Philadelphia, Chester, and Delaware Counties, Pennsylvania, and northern Delaware (in a line from Newark to Wilmington) are underlain mostly by these

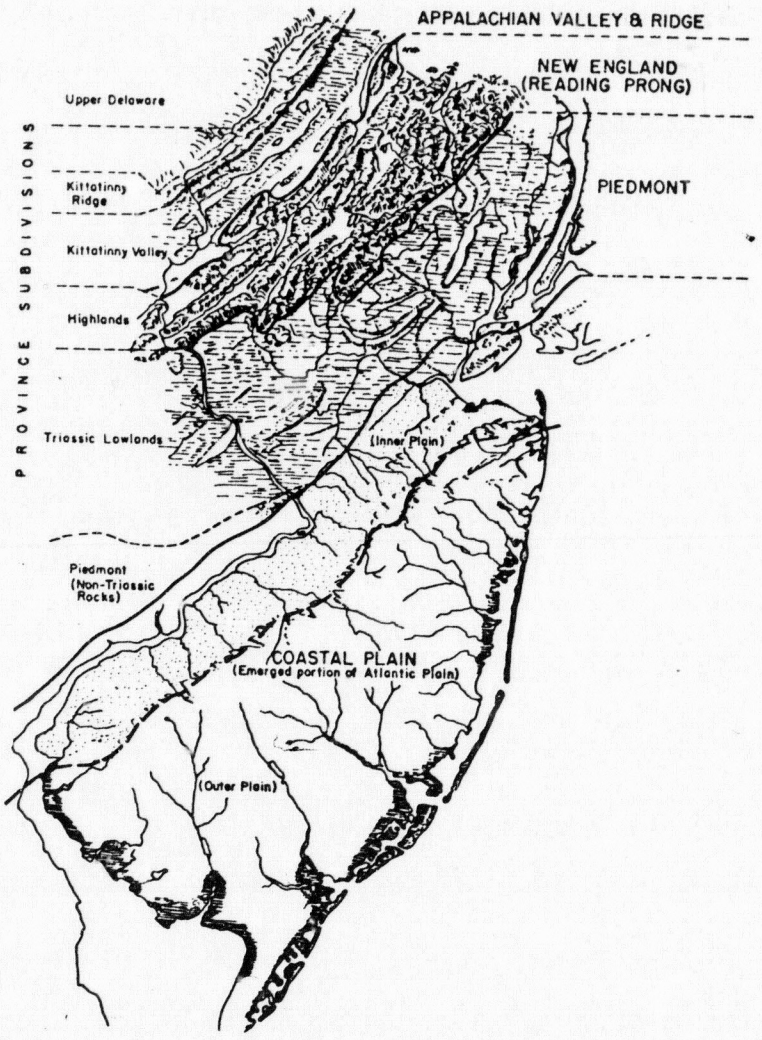


Figure II-12. Physiographic Provinces of New Jersey (From Widmer, 1964)

igneous and metamorphic rocks. Continuing down the Delaware River from the Christina River to the Chesapeake and Delaware Canal, moderately high hills of Cretaceous and Pleistocene age are found close to narrow marshlands. Below the Canal to the Atlantic Ocean, broad marshes fronted by occasional pocket beaches have been formed on Tertiary and Quaternary sediments. The Atlantic coast of Delaware consists of beaches interfaced or backed by salt marshes. Bay mouth barriers are located adjacent to the coastal lagoons of Rehoboth Bay, Indian River Bay, and Little Assawoman Bay.

Since the Delmarva Peninsula is primarily unconsolidated Tertiary and Quaternary sediments, relief is quite low. The barrier island fronting Assawoman Bay continues in front of Isle of Wight Bay down to Ocean City where it is broken by an inlet, then Assateague Island fronts Chincoteague Bay past the Virginia/Maryland border. This nearly 100 km (62 miles) stretch is a beach/lagoon or bay/marsh complex. The remainder of the peninsula facing the Atlantic is lined with shifting barrier beach/marsh complexes.

From Cape Charles to Occohannock Creek along Chesapeake Bay the shoreline consists of beaches whereas north to the Maryland/Virginia border, marshes predominate. Marshes and swamps are then found along the Maryland Bay shoreline north to the Choptank River. The remainder of the peninsula is highly indented by creeks and rivers which have cut through the low-lying terrace material and brush.

The Fall Line (continuing from Wilmington to Baltimore to Washington) separates the Piedmont hills from Tertiary and Quaternary sands and gravels which assume more relief along Maryland's Chesapeake Bay western shore than the Delmarva Peninsula. Only a few isolated beaches are found on the western bay shoreline from Baltimore to the mouth of the Patuxent River. Marshes have developed in Quaternary sediments along the rest of the Virginia Chesapeake Bay shoreline with higher elevations found in the Tertiary formations further inland.

b. Soils

Information for this section is derived from the National Atlas of the United States (1970) portrayal of soil orders, suborders, and great groups of the U.S. (Soil Conservation Service, 1967), and from unpublished materials from the Soil Conservation Service (1970).[1] The classification scheme used describes the soil after considering its mineralogic and organic components, moisture content, soil temperature, and slope characteristics. This information is provided for onshore-related planning purposes rather than for assessing potential impact on the proposed action. However, the information is generalized in nature, and more detailed analyses of local soils would

[1]Detailed, unpublished maps of soil types are available for inspection at the BLM New York OCS Office, Six World Trade Center, Suite 600D, New York, New York.

be necessary for any specific onshore siting appraisals. Figure II-13 shows the generalized soil types of the Mid-Atlantic region.[1] Manhattan, Staten Island, parts of Long Island, and much of northern New Jersey are covered by Inceptisols: soils that have weakly differentiated horizons; materials in the soil have been altered or removed but have not accumulated. They are usually moist, but during the warm season of the year are dry part of the time.

Parts of Long Island and southern New Jersey are covered by Entisols; soils with no defined soil horizons. All of the Delmarva Peninsula, western Maryland, southeastern Virginia (not shown on Figure II-13), and part of southern New Jersey are covered by Ultisols: soils that are low in alkalinity and have subsurface horizons of clay accumulation; they are usually moist, but during the warm season of the year, some are dry part of the time.

Two small areas of southern Long Island have Spodosols: soils with low base supply that have in subsurface horizons an accumulation of amorphous materials consisting of organic matter plus

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[1]Not all urban areas or wetlands are shown on this illustration or Visual 3. The reader is urged to use Visuals 5 and 4, respectively, to see more complete depiction of those Mid-Atlantic characteristics.

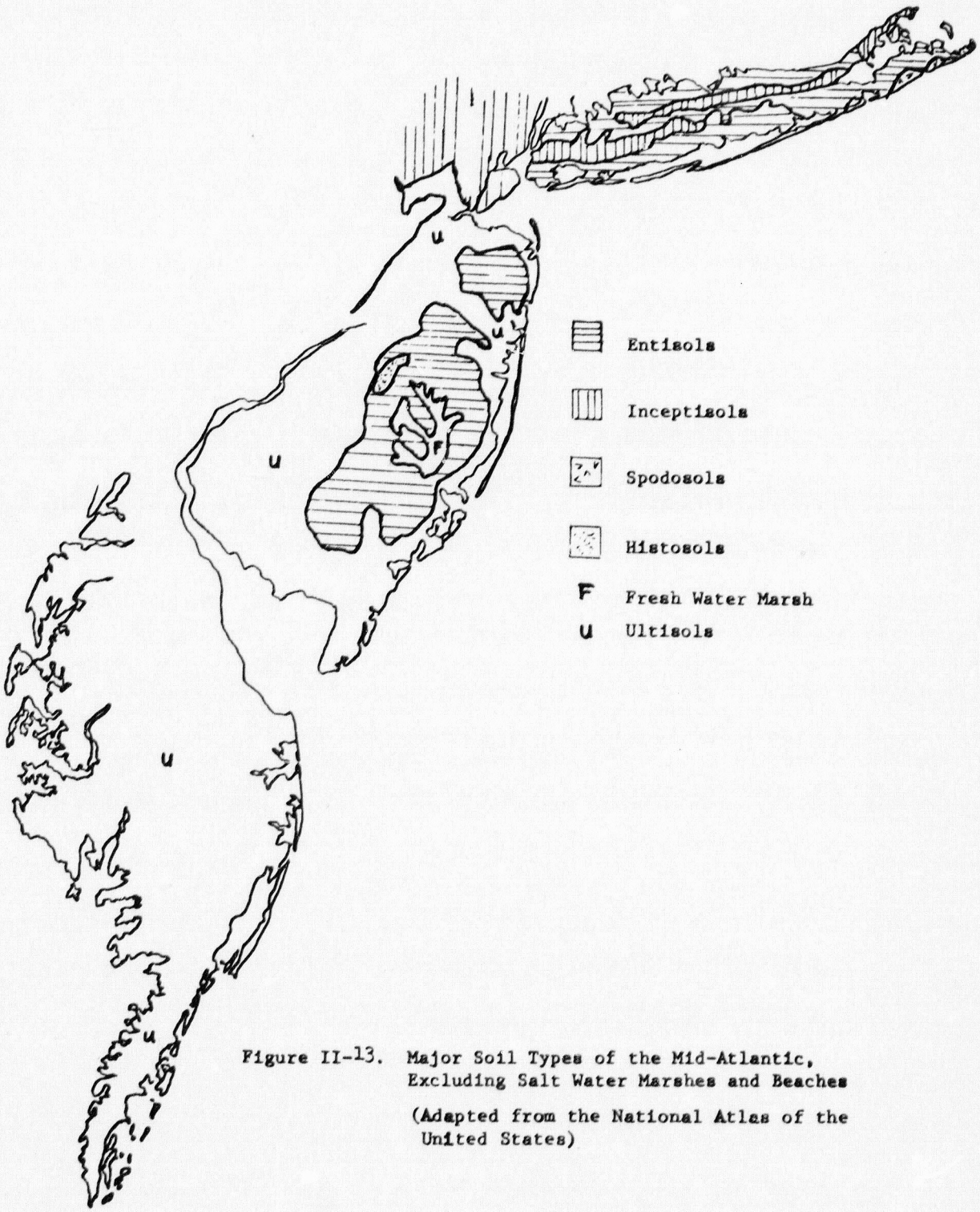

Figure II-13. Major Soil Types of the Mid-Atlantic, Excluding Salt Water Marshes and Beaches

(Adapted from the National Atlas of the United States)

compounds of aluminum and usually iron. They are formed in acidic, mainly coarse textured, materials in humid and mostly cool or temperature climate. Found in the Pine Barrens of New Jersey is a small region of Histosols: wet, organic soils formed in swamps and marshes; includes soils in which the decomposition of plant residues ranges from highly decomposed to undecomposed.

Visual # 3 depicts soil limitations that could be of concern for onshore shallow excavations and foundations within the region. A detailed discussion is included in Appendix 6 for how this visual was prepared and what the various limitations actually are. Parts of northern New Jersey, southern New York (plus a small area of eastern Long Island), southern New Jersey, and the central Delmarva Peninsula have soils with engineering limitations. Areas of wetlands soils, plastic clay, and saprolite soils require critical design techniques to accommodate potential hazards. However, it should be noted that even though engineering limitations may exist for an area, they can be overcome and, in fact, have been in many parts of the Mid-Atlantic.

c. Hydrology

Practically all water, surface and subsurface, in the region is derived from precipitation which drains both into rivers and ground water aquifers. Figure II-14 illustrates

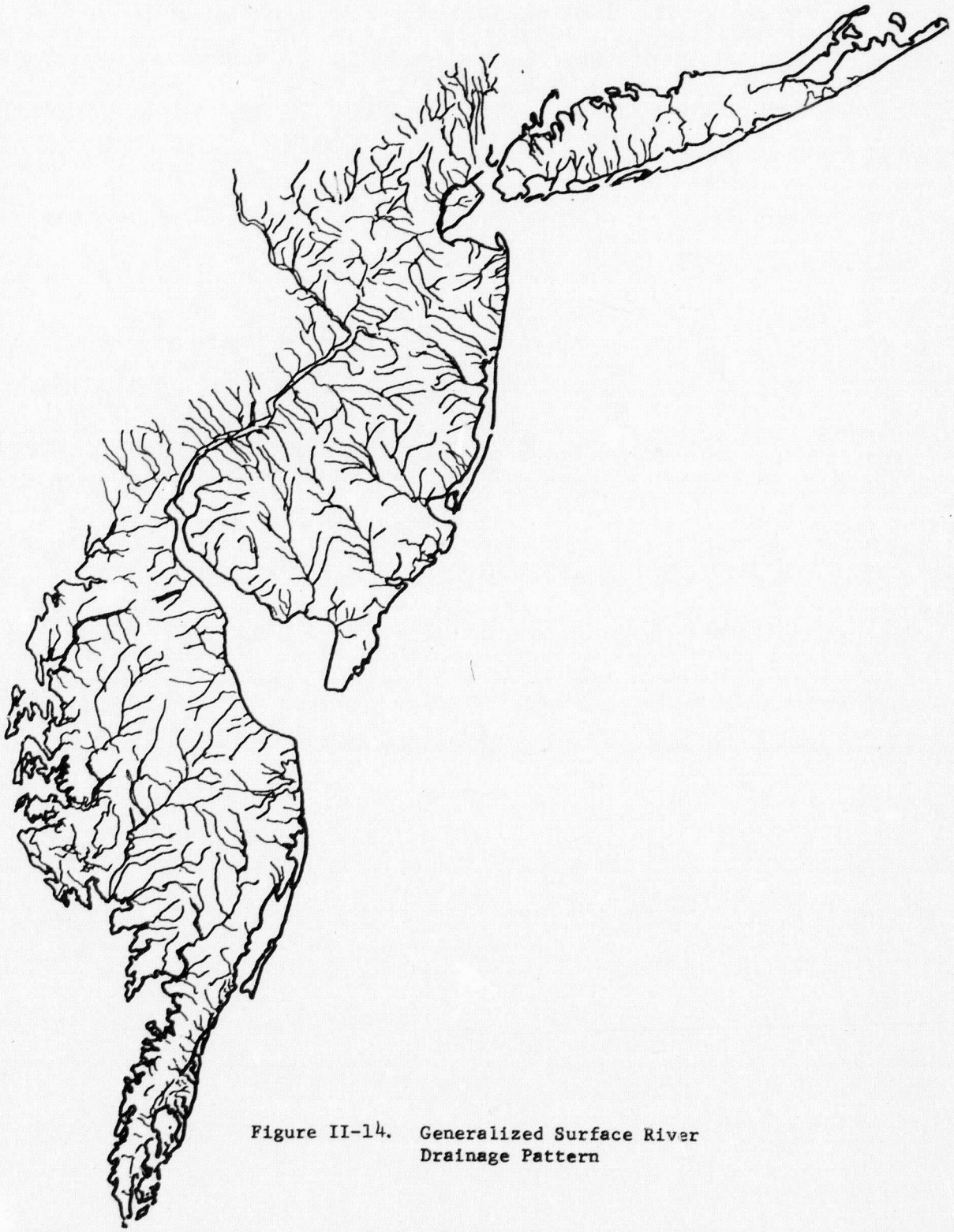

Figure II-14. Generalized Surface River Drainage Pattern

some of the Mid-Atlantic drainage patterns. Rivers in southern Long Island, the eastern part of New Jersey, and the southeastern part of the Delmarva Peninsula drain towards the Atlantic Ocean. Rivers in the northern half of Long Island drain into the Long Island Sound. The Delaware River receives water from eastern Pennsylvania, southwestern and southern New Jersey, and eastern Delaware. Chesapeake Bay receives water from Maryland and Virginia's mainland shore and the western half of the Delmarva Penninsula.

Principal aquifers of Long Island are Pleistocene glacial materials and the Cretaceous Magothy and Raritan (Floyd Sand Member) Formations (Figure II-15). Table II-2 shows the thickness and transmissivity[1] for individual aquifers plus the total volume of fresh ground water for all aquifers of Long Island and estimated range of water which could be yielded by pumping from these aquifers.

Ground water aquifers of the New York City area are the surficial glacial deposits and Paleozoic crystalline metamorphic rocks (water contained in joints and fractures). Most water used in this area is derived from upstate New York.

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[1]The number of gallons of water that will move in one day through a vertical strip of the aquifer having a width of one foot and the height of the aquifer.

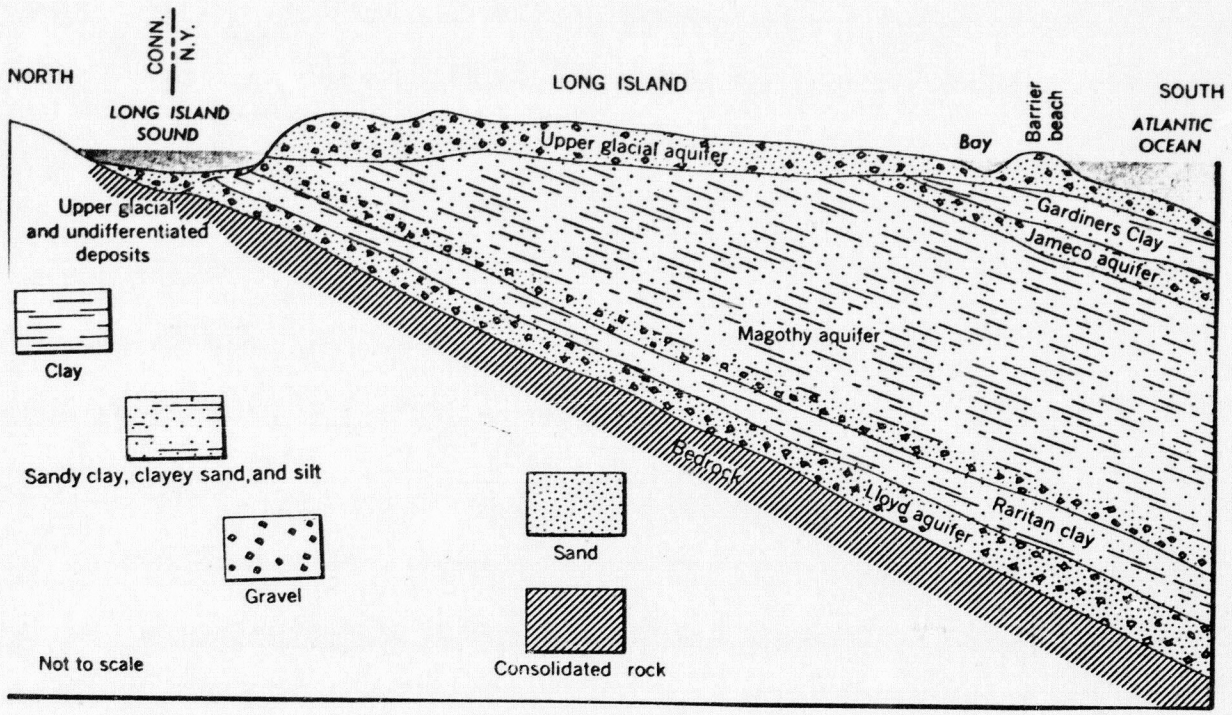

Figure II-15. Generalized Stratigraphy and Principal Aquifers of Long Island
(From Franke and McClymonds, 1972)

Table II-2. Aquifer Characteristics of Suffolk and Nassau Counties.
(Modified from Data in Franke and McClymonds, 1972)

Aquifer	Average Thickness (feet)	Average Hydraulic Transmissivity (gpd per ft)	Range of Estimated Total Yield, All Aquifers Combined (gallons)
Upper glacial	120	200,000	32,000,000
Jameco	80	100,000	
Magothy	580	240,000	to
Lloyd	240	90,000	16,000,000

Aquifer thickness and transmissivity estimates from McClymonds and Franke (excluding the forks). Estimates of total yield are based on multiplication of total volume of fresh ground water by both 5 and 10 percent (average specific yield for Long Island aquifers).

Aquifers in northeastern New Jersey are both stratified glacial materials and the sands and shales of the Triassic Newark Series (Nichols, 1968). Depending on location in southern New Jersey, various Coastal Plain formations are used as aquifers. Principal water-bearing formations are the Pleistocene Cape May, Pensauken and Bridgeton Formations, the Miocene Cohansey Sand and the Kirkwood Formation, Paleocene Vincentown Formation and Hornerstown Sand, and the Cretaceous Red Bank Sand, Navesink Formation, Mount Laurel Sand, Wenonah Formation, Englishtown Formation, Magothy Formation, and Raritan Formation (Jablonski, 1968). Potential water availability data by aquifer for New Jersey are available from U.S. Geological Survey Water Resources studies.

Cushing et al. (1973) prepared an extensive report on ground water resources in the Delmarva Peninsula. Table II-3 shows the stratigraphic relationships of the major aquifers across the Peninsula and those of New Jersey. Most of these aquifers are in sediments of Cenozoic age though Cretaceous strata can be utilized. Available water by aquifer for the Delmarva Peninsula is shown in Table II-4.

Many of these formations serving as aquifers continue downdip out to sea and towards the Baltimore Canyon Trough. Little information is available offshore to indicate where these aquifers terminate, either by change in lithologic type, permeability, or salt water contact.

Table II-3. Stratigraphic Correlations of Coastal Plain Formations from Virginia (Delmarva Peninsula) to New Jersey, and Aquifer Names for Delmarva Peninsula

System	Series	Stratigraphic units				Informal units	Aquifer names
		Virginia	Maryland	Delaware	New Jersey		
Quaternary	Holocene	--------	--------	--------	--------	Quaternary sediments	Quaternary aquifer
	Pleistocene	Columbia Group undivided	Columbia Group undivided	Columbia Group undivided	Cape May Formation Pensauken Formation Bridgeton Formation		
Tertiary	Pliocene(?)	--------	Brandywine Formation	--------	Cohansey Sand Kirkwood Formation	Miocene sediments	Pocomoke aquifer Manokin aquifer Frederica aquifer Federalsburg aquifer Cheswold aquifer
	Miocene	Chesapeake Group: Yorktown Formation; St. Marys Formation; Choptank Formation; Calvert Formation	Chesapeake Group: Yorktown Formation; St. Marys Formation; Choptank Formation; Calvert Formation	Chesapeake Group undivided			
	Oligocene						
	Eocene	Chickahominy Formation Nanjemoy Formation	Piney Point Formation Nanjemoy Formation	Piney Point Formation Nanjemoy Formation	Piney Point Formation Shark River Formation Manasquan Formation	Eocene and Paleocene sediments	Piney Point aquifer
	Paleocene	Aquia Formation	Aquia Formation Brightseat Formation	Rancocas Group: Vincentown Formation; Hornerstown Sand	Vincentown Formation Hornerstown Sand		Aquia and Rancocas aquifer
Cretaceous	Upper Cretaceous	Mattaponi Formation	Monmouth Formation Matawan Formation Magothy Formation Raritan Formation	Mount Laurel Sand Matawan Group: Marshalltown Formation; Englishtown Formation; Merchantville Formation Magothy Formation	Tinton Sand Red Bank Sand Navesink Formation Mount Laurel Sand Wenonah Formation Marshalltown Formation Englishtown Formation Woodbury Clay Merchantville Formation Magothy Formation	Marine Cretaceous sediments	Magothy aquifer
	Lower Cretaceous	Potomac Group: Patapsco Formation; Patuxent Formation	Potomac Group: Patapsco Formation; Arundel Formation; Patuxent Formation	Potomac Formation	Raritan Formation and Potomac Group undifferentiated	Nonmarine Cretaceous sediments	Nonmarine Cretaceous aquifer

EXPLANATION

-------- No name assigned

Section not present

(From Cushing, Kantrowitz, and Taylor, 1973)

Table II- 4. Delmarva aquifers and water availability
(From Cushing, Kantrowitz, and Taylor, 1973)

Aquifer	Estimated Quantity of Fresh Water Perennially Available (mgd)
Nonmarine Cretaceous	80
Magothy	10
Aquia and Rancocas	190
Piney Point	(1)
Cheswold	80
Federalsburg	50
Frederica	50
Manokin	(2)
Pocomoke	(2)
Quaternary	1040
Total	1500

[1]Included with Cheswold aquifer.

[2]Included with Quaternary aquifer

Salt water encroachment has been reported in several Coastal Plain wells as a result of man's water use exceeding natural recharge. Frank and McClymonds (1972) found that the eastern half of Long Island has little or no salt water encroachment problem while the western half will face in the future or is encountering intrusion now. This situation has remained fairly static over the last decade[1] although the State of New York (Written Testimony, Des for OCS Proposed Lease Sale #40, 1976) has reported that North Haven and some other portions of Eastern Long Island are experiencing salt water intrusion now.

Salt water intrusion has been reported in the Raritan and Magothy Formations in New Jersey, and especially in Cape May, Atlantic, and Cumberland Counties and parts of Ocean County where they are not used as sources of fresh water. Additional salt water invasion has been reported in coastal areas for the major Quaternary aquifers. Cushing et al. (1973) have shown that potential salt water intrusion in the Delmarva Peninsula is most noticeable in the Quaternary aquifers, thought it may appear in the Tertiary aquifers as well.

Ground water for the Piedmont of Delaware comes primarily from the Paleozoic Cockeysville Limestone, though some water is obtained from fractures and joints in the igneous and metamorphic units. Philadelphia's ground water is derived from the

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[1]U.S. Geological Survey, Water Resources Division, Mineola, New York, personal communication, 1975.

Raritan and Magothy Formations and secondary fracturing in the Paleozoic Wissahickon Schist.

The Western Shore of Maryland and mainland southeastern Virginia obtain water supplies principally from the Potomac Group, Upper Cretaceous formations (Magothy and Monmouth), Paleocene and Eocene Pamunkey Group, Miocene Chesapeake Group, and Quaternary Columbia Group (U.S. Army Corps of Engineers, 1973b).

5. Potential Geologic Hazards

The following section details the available knowledge on potential hazards in the Mid-Atlantic study area. Section 6, following, provides a brief overview of some of the ongoing studies to gather new information and what some of the data needs are.

a. Seismic

Although the East Coast of the United States is not located near the edge of the North American continental plate, many earthquakes have occurred in the area. The majority of the quakes in the Mid-Atlantic have been minor (Mercalli VI or less, damage slight). Since the 1600's two events of Mercalli intensity VII (damage considerable in poorly built structures, slight to moderate in well built ordinary structures) have occurred in New York City, one in Asbury Park, New Jersey, and one in Wilmington, Delaware (U.S. Department of Commerce, 1973). Accordingly, the Mid-Atlantic area has been classified as having minor seismic risk. A

good discussion of earthquake prediction can be found in the May 1975 Scientific American article by Frank Press.[1]

Visual 3 shows the approximate epicenters of the various events since 1800[2]. The Geological Survey (1975) considers seismic risk for the Mid-Atlantic OCS as moderate (in comparison with other OCS operating areas such as the Gulf of Alaska and Southern California) due to the number of events near Wilmington, Delaware, coastal New Jersey, New York, and offshore on the shelf and slope. On the other hand, McClelland (1975) considered the seismic risk as minimal. It should be pointed out that very few seismic occurrences have been reported for the Mid-Atlantic OCS, probably due to the lack of observations, the incomplete seismograph network onshore, or simply the lack of recordable events.

Tsunamis, or seismic sea waves, are large oceanic waves that are generated by earthquakes or large submarine landslides. Tetra Tech (1974) cites no records of local or distantly generated Tsunamis ever causing damage in the Mid-Atlantic, and reported to the CEQ that Tsunamis do not pose a threat to offshore petroleum facilities in the proposed sale area.

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[1]Frank Press, "Earthquake Prediction," Scientific American, Vol. 232, No. 5 (May 1975), pp. 14-23.

[2]Locations indicated are from Hadley, J. B., and Devine, J. F., 1974, Seismotectonic Map of the Eastern United States. USGS Miscellaneous Field Studies Map, MF-620.

b. Shallow Fault Displacement

The present state of the art is such that active faults can be identified and located through detailed geologic mapping, seismic study, trenching, and geophysical work.[1]

The only displacements found thus far in the proposed leasing area were located by Sheridan and Knebel (1975a). They found shallow faults (1 to 2 km apart) south of Hudson Shelf Valley which may be associated with a deeper fault over a basement high (Visual No. 3). These normal faults are buried by more than 7 m (23 ft) of sediment, have displaced strata as much as 1.5 m (5 ft), and have not moved since perhaps the late Pleistocene (Sheridan and Knebel, 1975b).

Other more deeply buried faults associated with piercement structures are also known to exist in the area (USGS, 1975; Sheridan, 1975); their approximate locations are shown on Visual # 3.
Movement of these deeper faults stopped by the Tertiary and they should be considered inactive.

[1]Refer to Sections II.A.6, III.B.3., and Chapter IV for further discussion of USGS activities in this area and requirements of lessees.

c. Other Shallow Subsurface Hazards

Slumping is the sliding down of a mass of unconsolidated sediment on an underwater slope. Although slumps are known to exist on the Continental Slope and Rise at the base of canyons, none are found to lie within the proposed sale area. K. O. Emery (written testimony, public hearing, DEIS proposed OCS Lease Sale #40, 1976) states that, "Neither slides or turbidity currents should be initiated on the shelf in the area of the proposed sale, and those on the Continental Slope and in the canyons should not affect the shelf." McClelland (1975) discussed in some detail engineering characteristics of the shallow subsurface in the Mid-Atlantic. Based on data from Texas Tower, Coast Guard light station, and nuclear power plant borings, sediment types encountered were mostly dense, fine-to-medium grained sands with some fine grained layers of low-to-moderate strength. In his opinion:[1]

> It now appears probable that the pile-supported templet-type structure will be well suited for construction of fixed, semi-permanent drilling and production platforms. This observation is supported by the successful operation of several Coast Guard light stations built using this system. The fine to medium sands which predominate on the shelf can provide almost unlimited capacity in support of compressive axial loads on piles and also are relatively favorable from the standpoint of lateral support. The most likely problems with this foundation system are associated with pile installation procedures and the development of adequate tension capacity.

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[1] Mid-Atlantic OCS Environmental Assessment, 1st Quarterly Report for the Period 30 June-30 September, 1975--A Report to the Bureau of Land Management.

Pile driving hammers with rated energy in excess of 600,000 ft lb and stronger supports (like those developed for use elsewhere) are normally used when these latter problems arise.

Visual 3 shows the location of subsurface channels in the Mid-Atlantic OCS. Many of these channels could have been filled with poorly compacted fine grained sediment during marine transgressions. In addition (as stated in Section II.A.3. above), lagoonal sediments may underlie the present day sand surface. The USGS Marine Geology Branch[1] has found "a fairly widespread layer or layers of stiff clay that underlies the predominant surficial sand layer in several areas of the Baltimore Trough...it comes close to the surface, less than a few meters in several localities that (were) cored and was observed during several dives in the submersible to crop out at the bottom." Engineering studies conducted on core samples found the sediment to be normally consolidated medium stiff clay with unconfined shear strength of 0.5 to 1 ton/square foot, meaning that it would be capable of supporting light structures.[2]

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[1]Mid-Atlantic Environmental Assessment, 1st Quarterly Report for the Period 30 June-30 September, 1975--A Report to the Bureau of Land Management.

[2]D. Sylvester, USGS Marine Geology Branch, personal communication, 1976.

This clay at the shallow depths it is found should not present a problem for offshore platforms or pipelines.

Nevertheless, if some areas of fine grained sediment are poorly consolidated, settling could occur under the weight of platforms, or liquefaction might result from earthquake tremors. Special engineering studies may be required to ensure safe platform construction and operation.

Subsidence onshore has been a significant problem for parts of California and Texas as a result of petroleum and water production. The withdrawal of subsurface fluids and resultant lowering of reservoir pressure causes sediment to lose strength and gradually collapse, lowering the height of the sediment column overhead. Pressure injection of water can arrest subsidence: the Wilmington field in California rebounded 24 cm (0.8 ft) vertically in four years. Subsidence potential is difficult to predict without the kind of information derived from field development activities. However, it can be detected and arrested so it is not expected to constitute an uncorrectable environmental hazard for the proposed sale area.

Section II.A.2. pointed out that the targeted Mesozoic rock may be mostly calcereous. Because solution cavities form easily in this type of rock, it is possible that problems might be encountered during drilling (lost

circulation of drilling mud or actual loss of drilling tools). However, since many of the world's largest producing oil and gas fields, ranging from the Gulf Coast to the Middle East, are found in calcareous formations, this problem is handled on a routine basis.

Hydrogen sulfide gas is occasionally encountered during drilling operations in other parts of the world. If encountered in even minute quantities, (the gas being transmitted through the drilling mud to the platform), in a worst case situation, death or paralysis could occur to surface personnel. A proposed OCS Order (Chapter IV) has been developed to handle this potential hazard.

Natural gas found in the shallow subsurface, before a conductor or a string of surface pipe has been installed, has been an occasional problem faced in the Gulf of Mexico and elsewhere. K. O. Emery stated (written testimony, public hearing, DEIS OCS proposed lease sale #40, 1976):

> Marsh gas forms in probably all of the fresh-water and salt water marshes that border the ocean in the Baltimore Canyon trough region...Seismic reflection profiles and drill hole logs show the presence of layers of silt and clay that may well be buried marsh deposits. In fact, samples of submerged ancient fresh-water peat have been dredged from the shelf surface. However, the many days of shipboard work in the region even in calm weather failed to produce observations of gas bubbles, unlike similar experiences off southern California. Presumably, the permeability of the sand atop buried marsh deposits is so great that the gas has been able to escape about as rapidly as it formed.

In any event this hazard can be detected (Sieck, 1975) and will be allowed for by geophysical studies before drilling commences in the event this proposed sale is held.

Despite the fact that no information is presently available on geopressures (high fluid pressures in the subsurface) in the Mid-Atlantic area, since no previous petroleum exploration has occurred here, this should not constitute a major hazard. Mud programs employing high density drilling muds, blowout preventers, and other safety devices (Section IV.D.) will greatly reduce any possibility of accidents because of geopressure in this proposed sale area.

d. Sediment Transport

The movement of bottom sediment in response to the hydraulic regime on the Mid-Atlantic Continental Shelf could cause problems for foundations and pipelines. Structures, such as fixed platforms, alter the localized movements of bottom water, and induced scour (sediment erosion) at their base may expose additional structural surface area (especially in shallow water or during severe storms when effective wave depth increases).

Sediment scour should not present a problem for properly designed and selected offshore platforms or rigs. Operations in active sand wave regions of the North Sea, Cook Inlet (tidal currents

approaching 9 knots), and Texas towers on Georges Bank have demonstrated the resistance of platforms to scour. Extra wall thickness on pilings will prevent their weakening due to increased horizontal stress if sand is eroded; the upper meters of sediment cover are assumed to be erodable in developing design criteria in areas where sediment transport is active.[1]

Contrary to the report by Emery and Uchupi (1972) that scour caused the removal of the Texas towers on Georges Bank, Rutledge[2] states that they were salvaged because the military radar systems were obsolete. Texas Tower #4 (located offshore Long Island) collapsed after a major storm, but Rutledge (a member of the designing firm) attributes the failure to damage caused to the structure while being towed from port (before

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[1] B. McClelland, McClelland Engineers, Houston, Texas, personal communication, 1975.

[2] Mueser, Rutledge, Wentworth, and Johnston Consulting Engineers, New York, personal communication, 1975.

emplacement); subsequent repair efforts to the damaged support had been unsuccessful.[1] Poor scour preventative design features caused the Sedco H semi-submersible rig to abandon operations in 30 meters of water on the Scotian Shelf after a major storm threatened the stability of the vessel (Wilson and Abel, 1973); proper matting over the pontoons or choice of a different rig would have avoided the problem.

One of the best indications of bottom sediment transport under natural conditions is the movement of sand waves across the Continental Shelf. Migration is most active between 0-40 m (131 ft) and appears to be dominated by current and storm waves (U.S. Geological Survey, 1975). Moody (1964), Ludwick (1972), Duane et al. (1972), and Field (1975) have demonstrated that at these shallower depths in the Mid-Atlantic, sand waves have migrated as much as 69 m a year (226 ft per year average over 53 years off Chincoteague, Virginia) with single major storms moving ridges as much as 82 m (250 ft).

Beyond the 40 m contour, sediment moves chiefly in response to storms. McClennon's (1973) research on the OCS offshore New Jersey found that significant transport can occur during these events.

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[1]Scour is reported to have occurred, however. (State of Delaware, written testimony, public hearing DEIS proposed OCS lease sale.)

McKinney et al. (1974) and Stubblefield et al. (1975) have proposed that ridges are formed in response to the helical flow structure in the flow field of major storms, with sand moving out of troughs and up ridges while lesser intensity and calm weather events (currents and biological activity) rework the sediment surface. Other transporting mechanisms include tidal currents, wind driven currents, benthic organisms, and internal waves. Pictures taken by camera placed near the ocean floor by the USGS as part of the Department's environmental studies program showed small-scale ripples (less than one foot) forming and moving; preliminary review of bottom current meter data indicated average current speeds of about 10 cm/sec and 34-44 cm/sec during a storm in February 1976.[1]

Erosion along the Mid-Atlantic coastline has been termed critical by the Army Corps of Engineers (1971). Visual 3 shows those areas of most concern. This factor should be problematic in selection of pipeline routing and maintenance, especially after storms when increased exposure of previously buried pipeline along a beach may occur.

[1] B. Butman, U.S.G.S., Marine Geology Branch, Woods Hole, Mass., personal communication, 1976.

e. Geological Hazards Summary

It is not entirely realistic to rate hazards since they vary greatly in areal extent, magnitude, intensity, chance of occurrence and degree of mitigation. Each hazard must be studied on a case by case basis in each particular area. However, keeping the above qualifications in mind, an attempt to rate the potential geological hazards for proposed Mid-Atlantic OCS oil and gas operations (exploration, development, and production) is shown in Table II-5.

6. Information Needs

As part of the BLM environmental studies program, the U.S. Geological Survey Office of Marine Geology over the last year has been conducting geological and geophysical research. This research is designed to obtain up-to-date information on potential shallow hazards, sediment transport, trace metal and hydrocarbon content of surficial sediments, and to learn more about the history of the Mid-Atlantic Continental Shelf.

In order to evaluate potential shallow hazards, Uniboom, Minisparker, and 3.5 KHz echo sounder systems profiles have been obtained across the Mid-Atlantic shelf. A summary of initial observations is included in Sections II.A.3. and II.A.5. In support of this research and the sediment transport studies, vibracores, gravity cores, side-scan sonar records, and grab samples have been collected. To determine

Table II-5. Potential Geological Hazards in the Mid-Atlantic OCS Area

The hazards are listed below with a proposed rating of greater to lesser.

Hazard	Ease of Identification	Ease of Hazard Alleviation
Sediment scour (pipelines)	Yes	Yes, but only with constant surveillance of pipeline burial
Sediment scour (platforms)	Yes	Yes - additional piling wall strength
Earthquakes	No	Variable - slight to moderate probability of occurrence
Rough sea floors, shipwrecks	Yes	Yes (moving off - directional drilling)
Fault displacement, gas seeps, and mounds	Yes (Geophysical surveys)	Yes (moving off - directional drilling)
Unstable bottom, steep slopes, gas charged, hurricane triggered	Yes (Geophysical surveys)	No (pipelines are high risk) extensive piling, platform strength
H_2S	Yes (Proper warning devices)	Yes (adherance to OCS Order No. 2)
Gas charged or geo-pressured zones	Variable	No (blowout preventers must be employed); semi-submersible or drillships are safer than platforms
Slumping, gravity triggered	Slump areas (Geotechnical surveys)	No (pipelines are high risk) extensive piling platform strength

Table II-5. Continued.

Hazard	Ease of Identification	Ease of Hazard Alleviation
Subsidence	Variable	Variable - affects coastal zone primarily
Ground water contamination	Yes (fresh water zones located by monitoring drilling muds, electro-log)	Yes - casing program

NOTE:
It is standard U.S. Geological Survey procedure in application-to-drill discussions to inform the applicant of all available data concerning bottom conditions, faulting, potential lost circulation zones, high pressures, or other potential geologically-related hazards, and to require the submittal of an operation plan that includes procedures to accommodate the above hazards.

bottom sediment transport rates and areas of active transport, information from the aforementioned systems, data from submersible (miniature submarine) observations, and observations over time of pipes emplaced on the ocean bottom are being used. As well, data are being collected from specially designed bottom-mounted tripods which contain a camera (taking pictures at regular intervals), a current meter, and sediment collector. Suspended sediment samples and transmissometer measurements are being taken higher in the water column.

Trace metal and hydrocarbon studies of bottom sediments are also being performed to establish an environmental baseline prior to any proposed exploration activities. It is the intent of the Bureau to continue monitoring studies if exploration, development, and production occur.

Other studies which are ongoing in the Mid-Atlantic OCS include the National Oceanic and Atmospheric Administration's Marine Ecosystems Analysis Program (MESA), individual research projects of NOAA, individual research projects of the U.S. Geological Survey, those of the Environmental Protection Agency, and university projects.

More comprehensive information about the Baltimore Canyon trough shallow and deep structure, stratigraphy, hydrocarbon potential, and hazards will be gained by the studies mentioned above plus published reports from offshore operators, if drilling becomes a reality.

Bottom sediment transport represents one major subject area where more comprehensive programs of research are needed. Continuation of the USGS, NOAA, Army Corps of Engineers, and university research plus operating experience on the OCS will provide a more complete understanding. Additional efforts might include tracer studies, side-scan sonar mapping and resurveys, comparison of previous and recent bathymetric maps, and integration with physical oceanographic research on bottom water circulation. Rudimentary models of two-dimensional sediment transport are in existence, though more comprehensive (perhaps three-dimensional models) are years away.

Additional knowledge of seismic activity on the shelf would be gained by the development of a more complete seismograph network onshore from that which now exists, and the emplacement of bottom-mounted units across the shelf.

7. Atlantic Region Overview of Geologic Resources

An overview of geologic resources of the entire Atlantic Outer Continental Shelf and Atlantic coastal areas may be found in the Final Environmental Impact Statement (EIS) on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Volume 1. Descriptions of geology, hydrocarbon potential and geologic hazards are included in pages 155-179. Nearshore and coastal geology is described on page 415. More information of landforms is included in the section on land characteristics, pages 431-449.

B. Meteorology

The climate of the Mid-Atlantic study area can be characterized as being in transition between humid subtropical and modified continental. The area lies in a zone where continental air masses generally move from the west and southwest. The Mid-Atlantic is also in the direct path of northerly moving warm air from the Gulf of Mexico. The presence of the Appalachians to the west and Atlantic Ocean to the east significantly affects the weather, which includes rapid changes and major storms.

A general description of meteorology for the Atlantic coastal region as a whole can be found in the Final Programmatic EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol. 1, pages 180-185. Comparisons of weather in the Mid-Atlantic to other offshore operating areas also can be found in the Programmatic EIS in Section III. C. 7.

1. Barometric Pressure

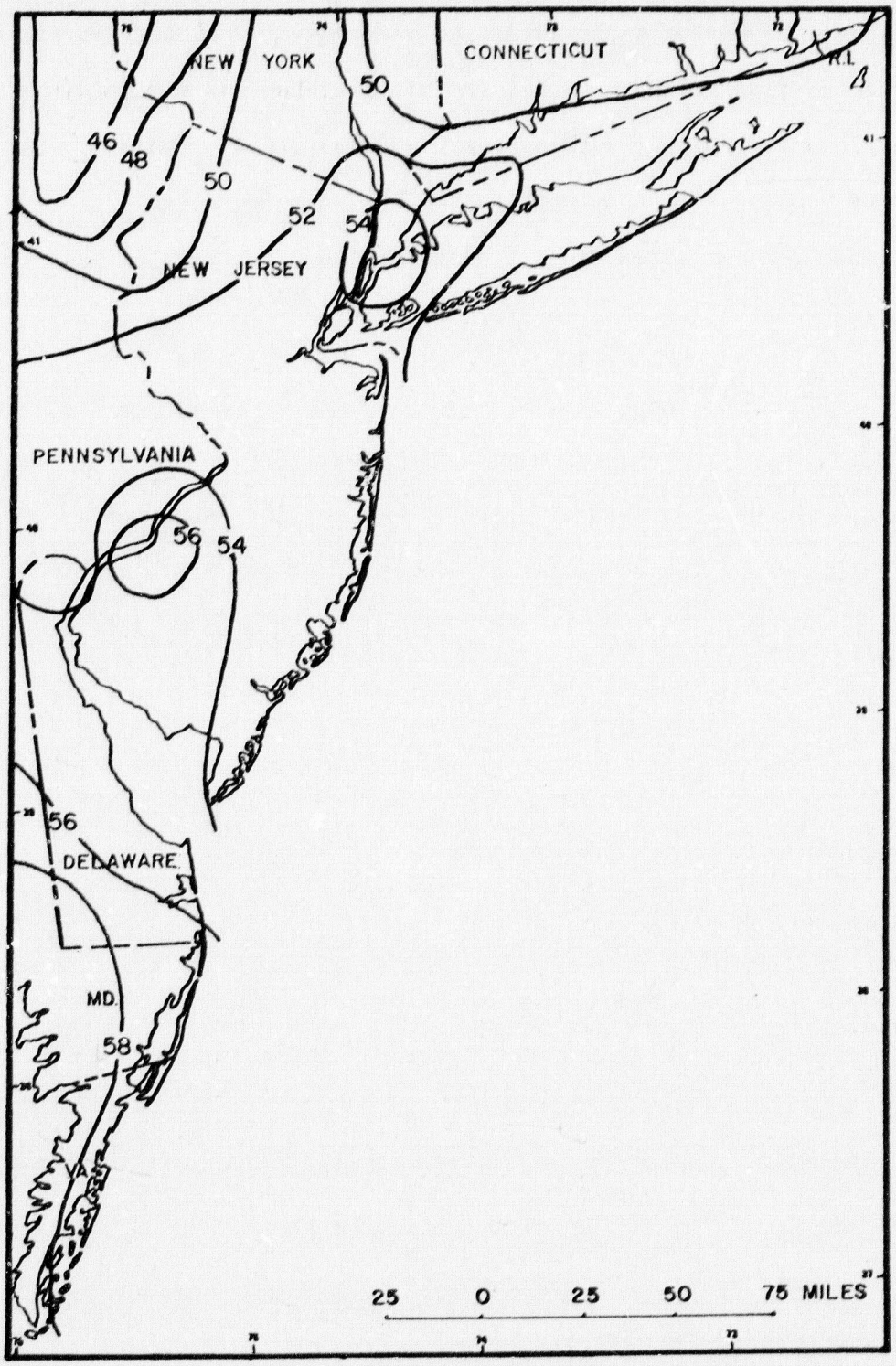
According to the U.S. Department of Commerce (1974), the position and intensity of the Bermuda-Azores high pressure system primarily controls the Atlantic coast's general surface wind pattern. The characteristics and location of this high-pressure system experience a large variability throughout the year. During the winter, the system is generally centered far to the southeast of the United States which allows major low-pressure storm systems to move through the Mid-Atlantic States. These lows are usually followed by interior continental highs which produce variable weather conditions.

In the spring, the Bermuda-Azores High migrates northward and begins to affect the southeastern United States, although the Mid-Atlantic States are still located outside the high pressure circulation. The most northerly and westerly position of the Bermuda-Azores High is attained during the summer and, at this time, the entire eastern seaboard is within its circulation. This causes the Mid-Atlantic region to have frequent showers and thunderstorms, warm temperatures with high humidities, and fairly low wind speeds. The summer also marks the beginning of the hurricane season. Finally, in autumn, the Bermuda-Azores High again moves southward and eastward and gradually the weather returns to its winter pattern.

Large, short-term variations of pressure are experienced by the movement of migratory pressure systems in a general west-to-east pattern through the area, though day-to-day changes are less marked in summer and have a lesser range than in winter (U.S. Department of Commerce, 1974, 1975). The normal atmospheric pressure ranges from 1014 to 1017 millibars in spring and early summer, to 1015 to 1020 in winter, depending on the location in the Mid-Atlantic (U.S. Department of Commerce, 1974, 1975).

2. Air Temperature

The average annual air temperature over the Mid-Atlantic region is generally moderate, varying from approximately 46°F along the eastern New York-Pennsylvania border to approximately 58°F along the Delmarva Peninsula (Figure II-16). According to Brower et al.



MID – ATLANTIC REGION

Figure II- 16. Average Annual Temperature (^{o}F)
(Adapted from U.S. Army Corps of Engineers, 1972)

(1972), in any season, a change in the wind direction can cause a fairly large fluctuation in the temperature. Thus, during winter, a wind blowing from the south or southwest may bring in mild weather, while one blowing from the northwest will bring extreme cold. During summer, however, a wind blowing from the southwest or west will bring warm weather but one from the northeast may bring cool and chilly air.

July is the hottest month (average temperature 75°F) while February is the coldest (average temperature 32°F or less). Mean, maximum, and minimum temperatures for selected states are available from the Environmental Technical Applications Center (1967, 1969, 1970, 1974), Naval Weather Service Environmental Detachment (1973), and U.S. Department of Commerce (1974, 1975).

The Mid-Atlantic offshore area is normally divided into five regions: Quonset, New York, Atlantic City, Norfolk, and "Hotel" (Figure II- 17). An evaluation of air temperature data for these five respective regions on both a monthly and annual basis indicates that "Hotel" is the warmest of the regions with an average annual temperature of 20.0°C.[1] Its minimum value of 14.4°C occurs in March and its maximum of 26.2°C in August, a range of 11.8°C. This is the smallest range of the five regions and is due to "Hotel's" distance from shore (Havens et al., 1973.) The New York region, in contrast, has a range of 20.1°C, which is the greatest of the five regions.

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[1]Temperatures over land areas are normally read in degrees Fahrenheit (°F), whereas those over water are read in degrees Celsius (°C), also known as degrees Centigrade. To convert from one scale to another, one of the following equations is used: °C = 5/9 (°F-32) or °F = 9/5 (°C) + 32.

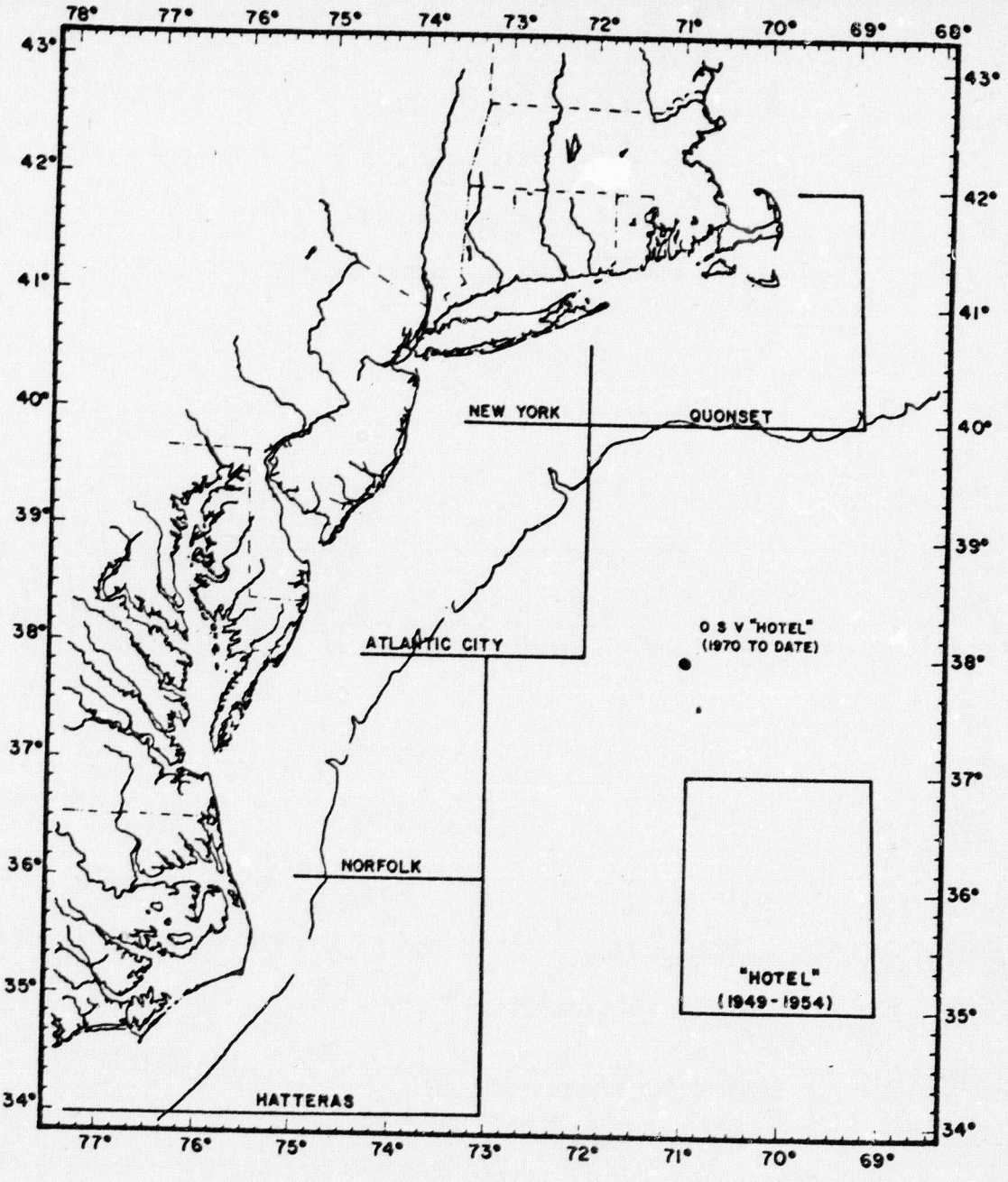

Figure II- 17. Location of Sea Areas Discussed in Text. (From Havens et al., 1973).

3. Precipitation

According to the U.S. Army Corps of Engineers (1972), precipitation over land in the Mid-Atlantic region has an approximate annual average of 46 inches, ranging from a high of about 50 inches in lower New York State to a low of approximately 44 inches along various sections of the coast (Figure II-18). Quite frequently, it is possible for large deviations from the average to occur, resulting in either extremely high or low stream flows. Droughts in the region can possibly last on the order of months or even years as was the case with the droughts of the 1930's and 1960's.

Snowfall for the Mid-Atlantic region averages approximately 20 inches per year with a range of less than 10 inches around the Virginia Capes to greater than 30 inches in northern New Jersey, southern New York and Connecticut (Figure II- 19).

Offshore precipitation is usually not measured by ships although precipitation frequency is measured (U.S. Department of Commerce, 1975). South of Sandy Hook to Cape Henry, it is found that during January a maximum of between 9.2 and 9.3 percent will occur while a minimum of between 3.5 and 5.0 percent will occur during June to July (U.S. Department of Commerce, 1974). According to the U.S. Department of Commerce (1974, 1974), snow is encountered in the offshore region from November to April with a maximum generally occurring in January and February. Snow occurring at sea, however, is little more than a minor restriction to visibility.

Figure II- 18. Average Annual Precipitation (Inches). (Adapted from U.S. Army Corps of Engineers, 1972).

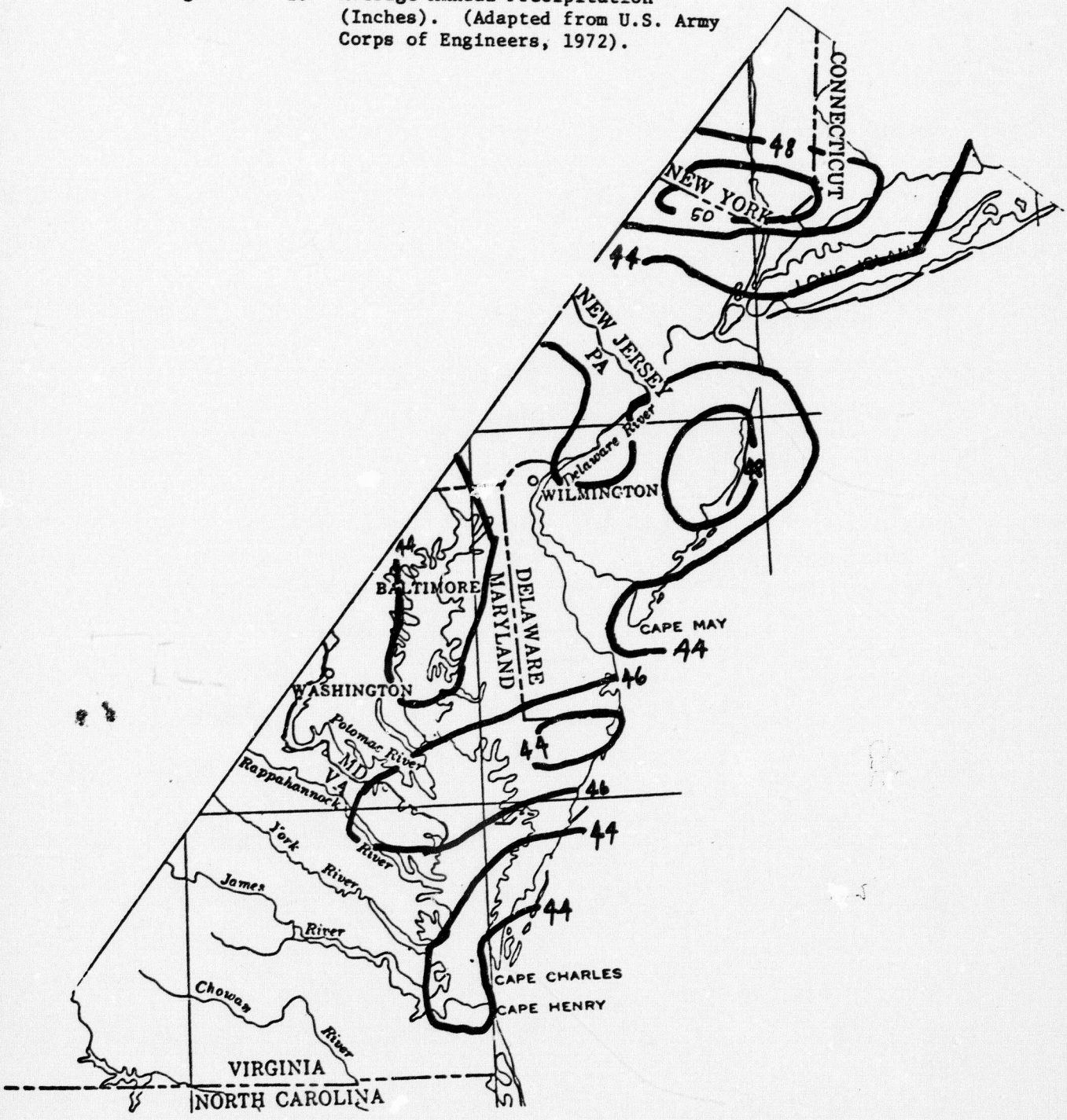

Figure II- 19. Annual Average Snowfall (inches).
(Adapted from U.S. Army Corps of Engineers, 1972).

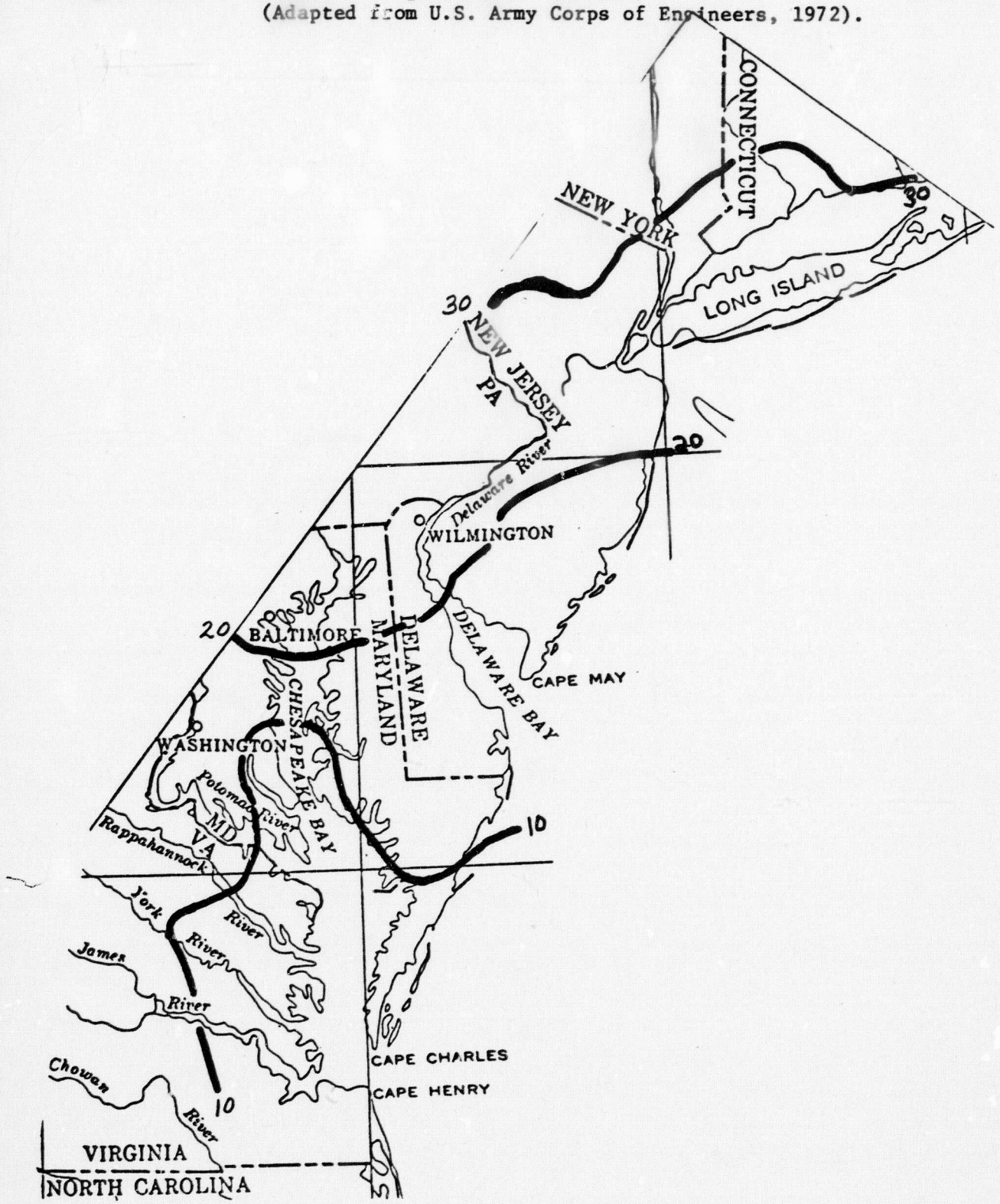

Table II-6 presents precipitation data on a percentage frequency basis by month for various offshore regions in the Mid-Atlantic area (Figure II-17). This data is based upon ship observations and since ships tend to avoid bad weather, it is biased toward good weather (U.S. Department of Commerce, 1974, 1975).

4. Surface Winds

The surface winds over the Mid-Atlantic region (both onshore and offshore) generally come from a prevailing westerly direction throughout the year. There is an overall shift to the northwest during winter and to the southwest during summer (Havens et al., 1973; U.S. Army Corps of Engineers, 1972).

Annual average winds onshore in the study area range from a high of 9.5 knots at Atlantic City, New Jersey to a low of 7.8 at Wilmington, Delaware (U.S. Department of Commerce, 1974). Table II-7 summarizes wind conditions for several onshore stations. Data from the five sea areas encompassing the Mid-Atlantic are shown in Table II-8.

The offshore winds are, for the most part, higher than reported for onshore stations, though directions are basically the same as onshore. Visual 2 presents wind roses for the principal offshore areas. Storm wind frequencies offshore are also summarized in Table II-8. As can be seen, high winds occur more often in the winter and most commonly in the "Hotel" region. No analyses are presently available which provide hourly or daily persistence of high winds or winds blowing towards shore (E, NE, SE) for the offshore areas.

Table II-6. Offshore Precipitation (Percentage Frequency)

Region	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Quonset	12.0	12.7	10.2	9.8	6.7	4.8	5.5	6.4	7.2	7.0	9.3	12.7	8.5
New York	12.2	10.8	12.7	12.2	7.2	4.7	8.1	6.2	9.4	9.7	10.2	10.4	9.4
Atlantic City	9.2	8.8	7.7	5.7	5.2	3.7	3.5	4.6	5.1	5.2	6.8	7.8	6.1
Norfolk	9.3	9.2	7.1	6.5	5.3	4.4	5.0	4.8	5.7	6.1	6.5	7.5	6.5
"Hotel"	19.0	21.0	19.0	13.0	9.5	8.0	8.5	8.5	10.0	11.5	16.5	18.0	13.0

Source: Havens et al., 1973; U.S. Department of Commerce, 1974, 1975.

NEW YORK, NEW YORK

(Central Park Observatory)

Month	Wind (knots) Mean speed	Prevailing direction	Maximum speed and direction
	50	45	23
Jan.	9.5	NW	41NW
Feb.	9.6	NW	41NE
Mar.	9.7	NW	52NW
Apr.	9.2	NW	39NE
May	7.8	SW	33NE
June	7.1	SW	43SW
July	6.7	SW	37NW
Aug.	6.8	SW	31NE
Sept.	7.1	SW	38NE
Oct.	7.9	SW	35NE
Nov.	8.8	NW	61NE
Dec.	9.1	NW	37NW
Year	8.3	NW	61NE

ATLANTIC CITY, NEW JERSEY

(Aviation Facilities Experiment Center)

Month	Wind (knots) Mean speed	Prevailing direction	Maximum speed and direction
	11	5	10
Jan.	10.8	WNW	32WNW
Feb.	10.8	W	37W
Mar.	10.9	WNW	38WNW
Apr.	10.5	S	40ENE
May	9.5	S	28SW
June	8.5	S	32WNW
July	8.1	S	32ENE
Aug.	7.8	S	28NW
Sept.	8.4	ENE	52NW
Oct.	8.9	W	36WNW
Nov.	10.2	W	35W
Dec.	10.0	WNW	48N
Year	9.5	S	52NW

WILMINGTON, DELAWARE

(Greater Wilmington Airport)

Month	Wind (knots) Mean speed	Prevailing direction	Maximum speed and direction
	21	16	21
Jan.	8.5	WNW	40WNW
Feb.	9.1	NW	40WNW
Mar.	9.7	WNW	37SSE
Apr.	9.0	WNW	39WNW
May	7.7	S	39W
June	7.2	S	35SW
July	6.6	NW	42W
Aug.	6.4	S	35NNE
Sept.	6.9	S	35ENE
Oct.	7.0	NW	50SSW
Nov.	7.8	NW	40SSE
Dec.	8.0	WNW	38WNW
Year	7.8	NW	50SSW

WASHINGTON,

(National Airport)

Month	Wind (knots) Mean speed	Prevailing direction	Maximum speed and direction
	21	13	21
Jan.	8.9	NW	49NW
Feb.	9.2	S	50SW
Mar.	9.6	NW	52E
Apr.	9.2	S	49N
May	8.1	S	42S
June	7.6	S	50NW
July	7.2	S	47E
Aug.	7.1	S	43NE
Sept.	7.2	S	49SE
Oct.	7.5	SSW	68SE
Nov.	8.0	S	52E
Dec.	8.2	NW	54SW
Year	8.2	S	68SE

RICHMOND, VIRGINIA

(Byrd Field)

Month	Wind (knots) Mean speed	Prevailing direction	Maximum speed and direction
(a)	21	15	19
Jan.	7.0	S	35S
Feb.	7.5	NNE	39SW
Mar.	7.8	W	36SE
Apr.	7.7	S	35NW
May	6.9	SSW	39N
June	6.3	S	45NW
July	6.0	SSW	49NW
Aug.	5.6	S	47W
Sept.	5.9	S	39SE
Oct.	6.1	NNE	59SE
Nov.	6.5	S	30S
Dec.	6.5	SW	35SW
Year	6.4	S	59SE

NORFOLK, VIRGINIA

(Norfolk Regional Airport)

Month	Wind (knots) Mean speed	Prevailing direction	Maximum speed and direction
	21	15	16
Jan.	10.2	SW	49SW
Feb.	10.4	NNE	57SW
Mar.	10.9	SW	50W
Apr.	10.3	SW	54N
May	8.9	SW	46SW
June	8.2	SW	42NW
July	7.6	SW	55SW
Aug.	7.6	SW	50NE
Sept.	8.3	NE	63W
Oct.	9.0	NE	68S
Nov.	9.3	SW	45SE
Dec.	9.5	SW	42NW
Year	9.2	SW	68S

Table II-7. Average and Highest wind Speeds and Directions for Six Onshore Stations. (From U.S. Department of Commerce, 1974).

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Table II-8. Average Wind Speeds (Knots and Directions for Five Offshore Areas.

(Winds ≥ 34 Knots are given in percent frequency per month.)

Region		January	February	March	April	May	June	July	August	September	October	November	December	Annual
Quonset	Average	16.9NW	17.0NW	15.7W	13.3W	10.8SW	10.1SW	9.4SW	10.3SW	11.6SW	13.7W	15.5W	17.1NW	13.2W
	≥ 34 Knots	4.9%	5.9%	4.5%	1.9%	0.6%	0.2%	0.1%	0.3%	1.3%	2.5%	3.5%	5.0%	2.4%
New York	Average	15.1NW	15.3NW	13.7NW	12.5W	10.2SW	9.8S	9.3S	9.2S	10.9S	12.1NW	14.5W	15.4W	12.2W
	≥ 34 Knots	3.4%	3.7%	2.6%	1.3%	0.6%	0.0%	0.2%	0.2%	0.6%	1.8%	2.3%	3.3%	1.6%
Atlantic City	Average	16.5NW	16.1NW	15.1NW	13.1SW	10.9SW	10.3SW	10.5SW	10.7SW	11.8S	13.8N	15.2NW	15.6NW	13.2SW
	≥ 34 Knots	5.3%	4.9%	3.5%	1.6%	0.3%	0.2%	0.4%	0.5%	0.9%	2.0%	2.8%	3.6%	2.1%
Norfolk	Average	16.1N	15.7N	15.4N	13.8S	11.8S	10.9S	10.7S	10.9SW	12.2NE	13.9N	14.7N	15.2N	13.4N
	≥ 34 Knots	4.1%	3.4%	3.2%	1.3%	0.2%	0.3%	0.2%	0.5%	1.1%	1.9%	2.6%	3.3%	1.8%
"Hotel"	Average	21 SW	22 NW	22 NW	19 SW	17 SW	13 SW	12 SW	15 SW	16 E	15 E	18 NW	21 NW	18 SW
	≥ 34 Knots*													
	≥ 41 Knots	3.7%	4.8%	4.3%	3.5%	0.1%	0.4%	0.0%	0.5%	0.3%	0.6%	2.1%	2.0%	1.8%

*Not detailed in Havens et al.

Source: U.S. Naval Weather Service Command, 1970a, 1970b; "Hotel" data from Havens et al., 1973.

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Since the primary mission of the ocean vessel station "Hotel" is weather observation, it undoubtedly is more representative of marine weather conditions for its area than are the observations of the other four regions. The data reported for the other four regions is based on ships-in-passage (Havens et al., 1973). Comments received from the State of New York (Public Hearing, DES for Proposed OCS Lease Sale #40) suggest that easterly prevailing winds from "Hotel" for September and October may be attributable to high pressure systems moving north of the station.

5. Humidity, Sky Cover, and Visibility

Relative humidity in the Mid-Atlantic is high year round and seasonal variability is low; winds coming from onshore usually bring drier air to the area than oceanic winds. According to the U.S. Army Corps of Engineers (1972), the mean relative humidity onshore averages about 70 to 75 percent. Offshore, it is usually in excess of 70 percent (80 percent on occasion between Cape Cod and Sandy Hook), with an annual variation on the order of 6 or 7 percent (Harvens et al., 1973).

Cloud cover in the Mid-Atlantic both onshore and offshore is greatest in the winter. Skies are overcast along the coast from 1/3 to 1/2 the days in winter (slightly higher between Sandy Hook and Cape Cod) and from 25 to 35 percent in summer (U.S. Department of Commerce, 1974, 1975). Table II-9 shows sky cover data for the five sea areas in the area; skies are cloudier in the "Hotel" region than any of the others in the Mid-Atlantic offshore. Reliability of the data depends on the

Table II-9. Sky Cover and Visibility in the Quonset, New York, Atlantic City, Norfolk, and "Hotel" Areas
(Data from U.S. Department of Commerce (1974, 1975) and Havens et al., 1973)
Sky cover is given in eighths, overcast and visibility in frequency percent per month
Data for "Hotel" is approximated from graphs provided in Havens et al. (1973).

Quonset

Sea Area	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Sky cover	5.5	5.2	4.6	4.8	4.7	4.4	4.7	4.4	4.3	4.2	5.1	5.6	4.8
Sky overcast or obscured	44.3	39.7	36.2	41.1	37.3	31.7	35.1	29.0	29.9	26.9	37.4	42.9	35.8
Visibility < 2 naut. mi.	4.6	4.7	5.2	10.4	15.4	17.7	16.1	9.9	6.3	3.5	3.3	4.0	8.5

New York

Sea Area	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Sky cover	4.8	4.5	4.4	4.7	4.6	4.2	4.5	4.3	4.0	3.9	4.7	4.7	4.4
Sky overcast or obscured	36.1	36.0	35.4	36.8	34.2	25.5	30.9	28.8	27.9	26.1	34.7	33.9	32.2
Visibility < 2 naut. mi.	5.9	3.8	4.8	8.9	12.3	8.1	7.8	4.4	3.2	2.7	4.0	3.0	6.0

Atlantic City

Sea Area	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Sky cover	4.4	4.8	4.3	4.3	4.3	4.1	4.2	4.2	3.9	3.8	4.5	4.9	4.3
Sky overcast or obscured	39.0	37.9	31.9	32.8	30.4	27.0	23.0	23.1	24.3	23.7	28.9	33.5	29.6
Visibility < 2 naut. mi.	2.8	3.1	3.7	6.1	6.8	7.3	2.6	4.6	5.1	5.2	6.8	7.8	5.2

Norfolk

Sea Area	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Sky cover	4.9	4.8	4.5	4.2	4.3	4.2	4.3	4.4	4.1	3.9	4.3	4.8	4.4
Sky overcast of obscured	36.7	36.4	33.1	29.2	26.1	22.6	20.5	21.3	22.2	23.6	25.8	32.2	27.5
Visibility < 2 naut. mi.	2.7	4.5	4.1	4.8	4.7	3.4	0.9	1.1	1.6	1.5	2.0	1.9	2.8

Table II- 9. con't

"Hotel"	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Sky cover	6.1	6.3	6.4	5.3	5.2	4.9	5.0	4.7	4.4	5.1	5.7	6.1	5.4
Sky overcast or obscured (approx)	42%	43%	47%	35%	32%	30%	21%	18%	26%	26%	33%	40%	33%
Visibility < 2 naut. mi (approx).	3%	5%	3%	1%	1%	3%	<1%	1%	1%	<1%	1%	1%	1.8%

number of observations, and, as in most weather reports from ships, are slightly biased towards better conditions.

The following discussion on reduced visibility is taken from U.S. Department of Commerce (1974):

> Although generally good along these coastal States, visibility at any time can be hampered by smoke, haze, fog, and precipitation. The frequency of days with visibility less than 500 yards is 4 to 12 percent annually, mostly during the winter. Over the ocean areas, the percentage frequency of days with visibility less than 5 miles ranges from 5 to 15 percent in the southerly sections to around 20 to 30 percent in the northerly. Advection sea fog occasionally drifts onshore in the warmer months, burning off from the surface and usually lifting by afternoon. This process is reversed over the water area where fog usually dissipates from the top downward. Very shallow steam fog is sometimes experienced in the winter. This fog type, which occurs only in very cold weather when the air is much colder than the water, may hide the hull of a ship while leaving the masts and upper rigging plainly visible.
>
> Fog is more likely to form with light to moderate winds. The most frequent wind forces accompanying heavy sea fog are 2 to 4. Fog rarely forms or persists with gale force winds.

Greatest occurrence of reduced visibility is found in the summer, and in Quonset versus the other sea areas (Table II-9).

6. Storms

Storms which pass through the Mid-Atlantic area are of either the tropical or extratropical type. The low pressure center of an extratropical storm enters the region from either 1) the west, through the St. Lawrence Valley or the northeastern states, or 2) the southwest, moving along the coast. On the other hand, tropical storms form over the warm waters of the Caribbean, Gulf of Mexico, or

southern Atlantic Ocean (south of Cape Hatteras) and can move into the Mid-Atlantic along the East Coast or from offshore.

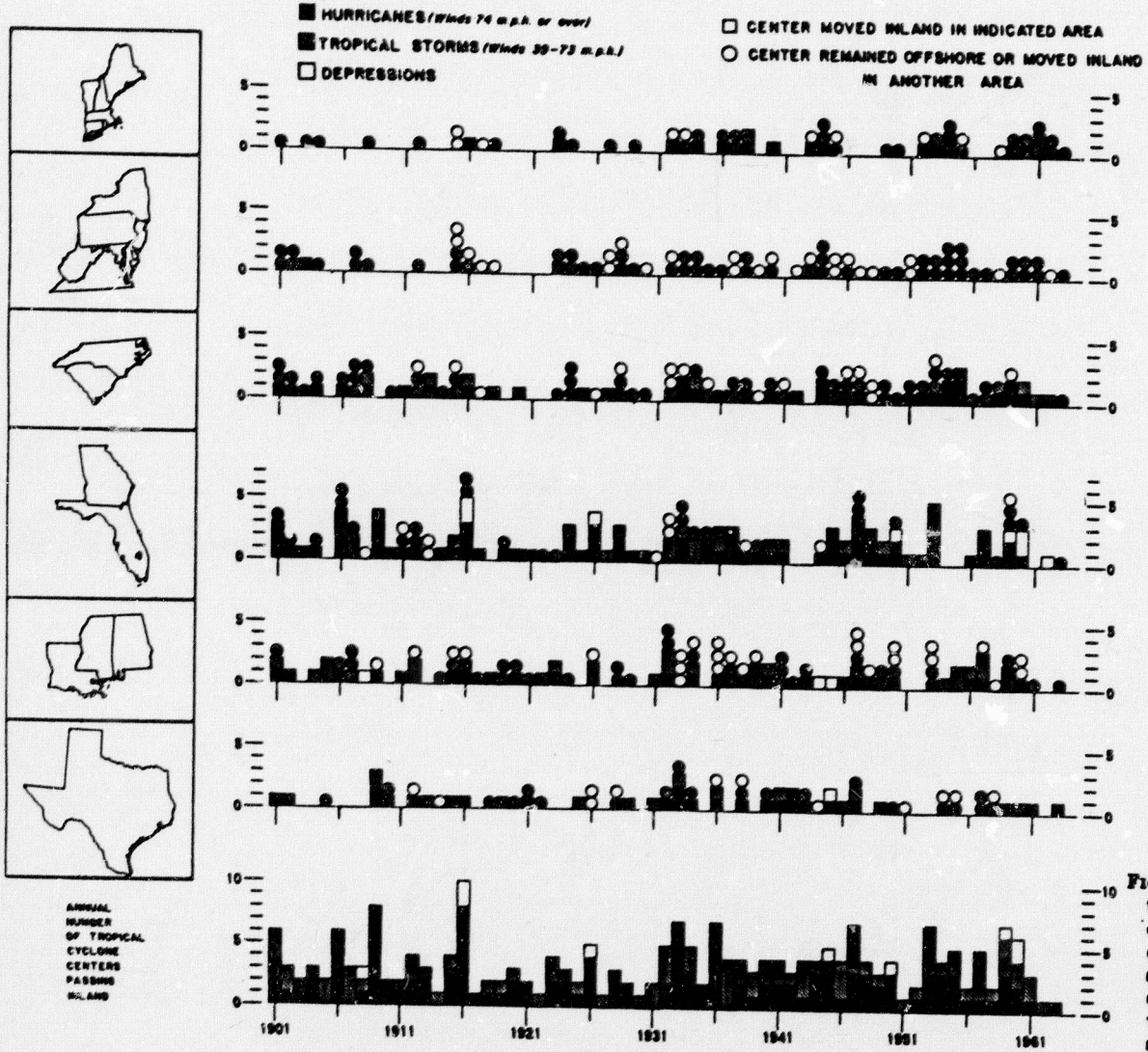
The extratropical cyclone which moves through the area from the southwest (called a Nor'easter storm because winds are from the northeast) may be more severe in terms of precipitation and winds than those moving in from the west. Nor'easters can form at any time, but are more frequent and intense between October and April (Brower et al., 1972); formation usually occurs between 30°-40° N and within about 100 miles off the coast with maximum severity near New England and Canada. Heavy snow or rain may be extensive before the storm center passes, and gales of hurricane force can occasionally occur (U.S. Department of Commerce, 1974).

Tropical cyclones are most likely to move north into the Mid-Atlantic area during late summer and autumn, though the frequency is low. These storms generally move through the region in a northeastern direction towards Nova Scotia and the adjacent waters. Many of these storms have taken on some of the features of extratropical cyclones before arriving in the region and are less intense than they were in southern latitudes. Tropical cyclones with winds of 34-63 knots are called tropical storms while those with winds greater than 63 knots are hurricanes.

According to Cry (1965), the regions of maximum tropical cyclone impact have been Florida, Texas, the middle Gulf Coast, and the Carolinas.

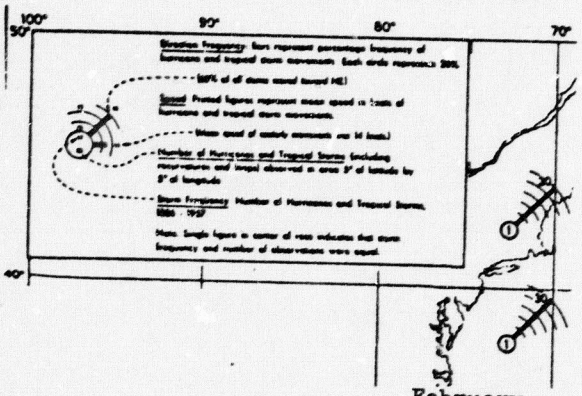
The northeastern U.S. has been severely affected only five times between 1938 and 1963 (1938, 1944, twice in 1954, and 1960). The approximate paths of all hurricanes which passed through the Mid-Atlantic area between 1901 and 1963 can be found in Cry (1965). Figure II-20 provides a comparison of tropical cyclone activity in the Mid-Atlantic and other east and Gulf coast states. Figure II-21 depicts tropical and hurricane storm roses for the Mid-Atlantic both onshore and offshore.

Thunderstorms usually occur during the summer months (U.S. Army Corps of Engineers, 1972) though they have occurred in the Mid-Atlantic during every month of the year. Percent frequency of thunderstorms in the five sea areas is less than three percent per month (U.S. Department of Commerce, 1974, 1975).

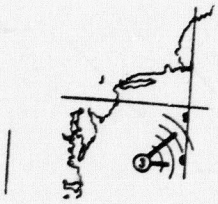


(Adapted from Cry, 1965)

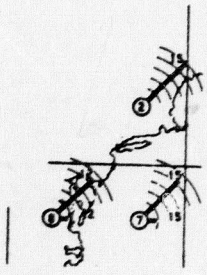
FIGURE -20.-Annual frequency of tropical cyclones moving inland over the United States or passing close enough offshore to affect significantly various sections of the coast with storm or hurricane winds, heavy rainfall, or high storm tides, 1901-1963.



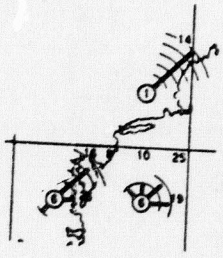
February



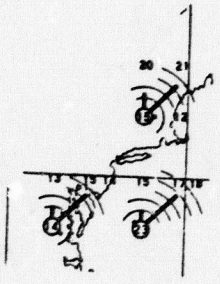
May



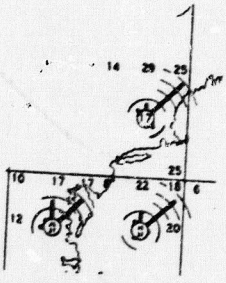
June



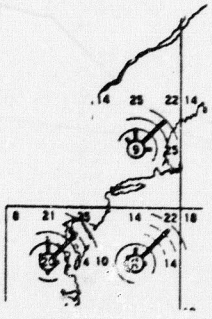
July



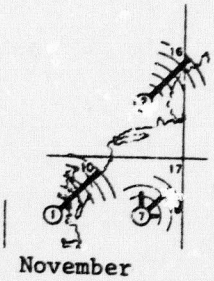
August



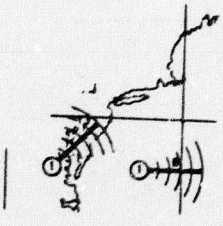
September



October



November



December

Figure II-21 . Tropical and Hurricane Storm Roses 1886-1957. Adapted from Brower et al., (1972). No such storms recorded in January, March, and April in the Mid-Atlantic.

C. Physical Oceanography[1]

1. Salinity

Salinity distribution over the Continental Shelf from Montauk Point to Chesapeake Bay is coastal in character, with values ranging from less than 32°/oo (parts per thousand) near the shore to 32-33.5°/oo over the middle of the Shelf, and finally to 34-35°/oo near the edge of the Continental Shelf (Bigelow and Sears, 1935). Along the bottom on the upper part of the Continental Slope, water slightly more saline than 35°/oo is found while slightly lower values are found deeper down the slope. Salinity can and does vary from year to year on the Mid-Atlantic shelf depending on current movement, outflow of streams and a variety of other factors, though the following discussion is a good approximation of the salinity fluctuations.

In 1935, Bigelow, in conjunction with Sears, described the annual salinity cycle for the Mid-Atlantic Bight, and it is from this work that a majority of the following was obtained.

Salinity reaches a maximum near the end of winter. At this time, salinities of approximately 34.1°/oo are found along the continental edge, of approximately 33.5°/oo along the middle of the shelf and of approximately 32-33°/oo at the inshore station with values of

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[1]An overview of physical oceanography of the entire Atlantic Coastal Region is included in the Final EIS on the Proposed Increase In Oil and Gas Leasing on the Outer Continental Shelf, Volume 1, pages 185-197.

32°/oo being confined to the mouths of Delaware and Chesapeake Bays and along shore from the latter. For the open sea, at this season, the lowest value recorded was approximately 30°/oo. The average bottom values are approximately 32.5°/oo at 20 m, 33.4°/oo at 30-45 m and 33.5°/oo at 45-60 m. At 60-100 m, the average values increase from about 32.9-33.4°/oo off Montauk Point to 34.2-34.6°/oo off Chesapeake Bay. Between 110-240 m and 300-500 m, values of 35-35.5°/oo are found near the bottom along the slope, usually as a continuous band.

In early summer, the salinity reaches a minimum due to the onshore surface runoff in the spring. Although this decrease is highly irregular, it is considerable over the entire shelf and, of course, decreases with depth. Minimum values which can be expected 8-10 miles offshore from Montauk are 30.8°/oo, from New York City are 27°/oo, from Atlantic City are 30.3°/oo, from Cape May are 30.5°/oo, and from the Virginia coast are 31.3°/oo. Values of less than 31°/oo are confined to small pools. Also, around May, a band of water of less than 32°/oo salinity develops along the shoreline as far east as 71°30' W. Surface water with a salinity less than 32°/oo develops to its greatest extent off New York where it may extend offshore for 90-100 miles. The steepest salinity gradients develop off New York City and Delaware Bay, where an average vertical gradient of more than 8°/oo per 20 m has been recorded. Steep gradients may also temporarily develop within short sectors along the edge of the Continental Shelf due to the interaction between shelf water

(less than 33°/oo salinity) and slope water (greater than 35°/oo salinity). During July-August, the average vertical gradient is steepest over the middle and outer belts of the Continental Shelf.

The normal salinity range for the entire region along the bottom is approximately 32.6-33.1°/oo at 40 m, 32.8-33.6°/oo at 50 m, 33.5-33.9°/oo at 75 m, and 33.6-34.6°/oo at 100 m. The 35°/oo salinity bottom water usually has its lower boundary lying between 250-500 m in depth. The bottom salinity shows an annual variation in summer of 0.5-1.5°/oo out to the 100 m contour line but shows a range of only about 0.5°/oo (35.0-35.5°/oo) below approximately 150 m.

During the late summer and into the autumn, surface cooling takes place and thus increase the vertical mixing. This causes the vertical salinity range to decrease; the surface salinity, however, increases and by November shows a considerable increase. The salinity remains fairly constant during December with an average gradient of less than 0.1°/oo per 20 m over the Continental Shelf. In January, there is an increase (0.3-0.4°/oo) in the surface salinity and the vertical distribution has returned to its winter state.

2. Temperature

The water temperature distribution throughout the Mid-Atlantic Bight undergoes an annual cycle, though it may undergo fluctuations from year to year. It has a minimum in February of less than 3°C occurring in the New York Bight and a

maximum in August of greater than 27°C occurring near Cape Hatteras (Bumpus, 1973b). In 1933, Bigelow described the annual temperature cycle in great detail, and it is from this work that most of the following was obtained.

The surface water temperature reaches a minimum in late February or early March with the lowest values (approximately 3°C) occurring near the coast and the highest (approximately 10°C) along the shelf edge. The difference ranges from 1°C to 3°C between New York to Chesapeake Bay with the coastal values being fairly constant. The vertical water column is found to be fairly homogeneous out to the 100 m line. The bottom water has a temperature of between 9-11°C along the 150-200 m zone with colder water (2-6°C) found inshore at depths of 20 to 30 m.

Soon after the minimum values are reached the temperature begins to increase due to the onset of spring. At first, this warming occurs throughout the entire water column especially near land. Around the beginning of May, the surface begins to warm at a much faster rate than the lower levels. In the southern part of the Bight, the temperature of the entire water column rises to 9-10°C, which is the same temperature as the bottom water along the shelf edge. At this point the thermocline is formed. In the northern part, however, the whole column continues to warm uniformly through the spring. The temperature gradient along the shelf during May, increases to 6°C at the surface and to about 4-5°C on the bottom. The gradient across the shelf, from the shoreline to the shelf edge,

decreases to 2°C at the surface. The spring warming is further complicated by cold water intrusions on the surface from the east and by offshore indrafts of warm water along the bottom.

During the month of June, the surface temperature continues to rise rapidly over the entire shelf and the thermocline increases in steepness. In August, the surface temperature reaches its maximum and has a latitudinal gradient of 4-5°C and a transverse to the shelf gradient of less than 3°C. Before the autumnal cooling, the thermocline becomes steepest. At this time, the surface water along the 35-50 m zone is 9-11°C warmer than the bottom water off Chesapeake Bay and 13-16°C warmer than the bottom water off Cape May and New York. It is also known that for most summers, the bottom water at mid-shelf (30-80 m) as far south as 38°N is colder than the water closer to shore or farther off shore.

The surface water begins to cool in early autumn and will vary locally. During this cooling period, the temperature becomes relatively uniform downward from the surface, and it is believed that by the end of October there is complete mixture down to a depth of about 40-50 m. By the middle of November, one can expect to find temperatures of 10-12°C off southern New England and New York, 12-14°C off Cape May, and 13-14°C off Chesapeake Bay.

In late autumn and early winter, the water cools most rapidly near the land and, by the middle of December, the coldest water can be

found inshore. At this time, the average temperature are approximately 5-8°C along the shore and 10-13°C along the shelf edge. Its range from north to south is about 2°C while the difference between the surface and bottom is normally less than 0.5°C. The cooling continues through the month of January and by the end of the month the temperature along the coast is 5-6°C, at mid-shelf 8-9°C, and 10-12°C along the shelf edge. During February, the cooling still continues until a minimum is reached by the end of the month, at which point the spring warming commerces and the cycle repeats itself. Figure II-22 (a through l) presents mean sea surface isotherms on a monthly basis for the Mid-Atlantic Bight.

3. Circulation

Over the Continental Shelf from Montauk Point to Cape Henry, most of the water is known as coastal or shelf water and experiences large seasonal variations. Beyond the shelf water is the slope water which at times may extend into the outer portions of the Continental Shelf. Still farther out is the Gulf Stream which may at times meander quite close to the Mid-Atlantic Continental Shelf and Slope with spin off eddies influencing slope water. Visual 2 shows water circulation on a generalized basis while Visual 6 shows monthly variations of inferred drift patterns based on Bumpus et al. (1973a).

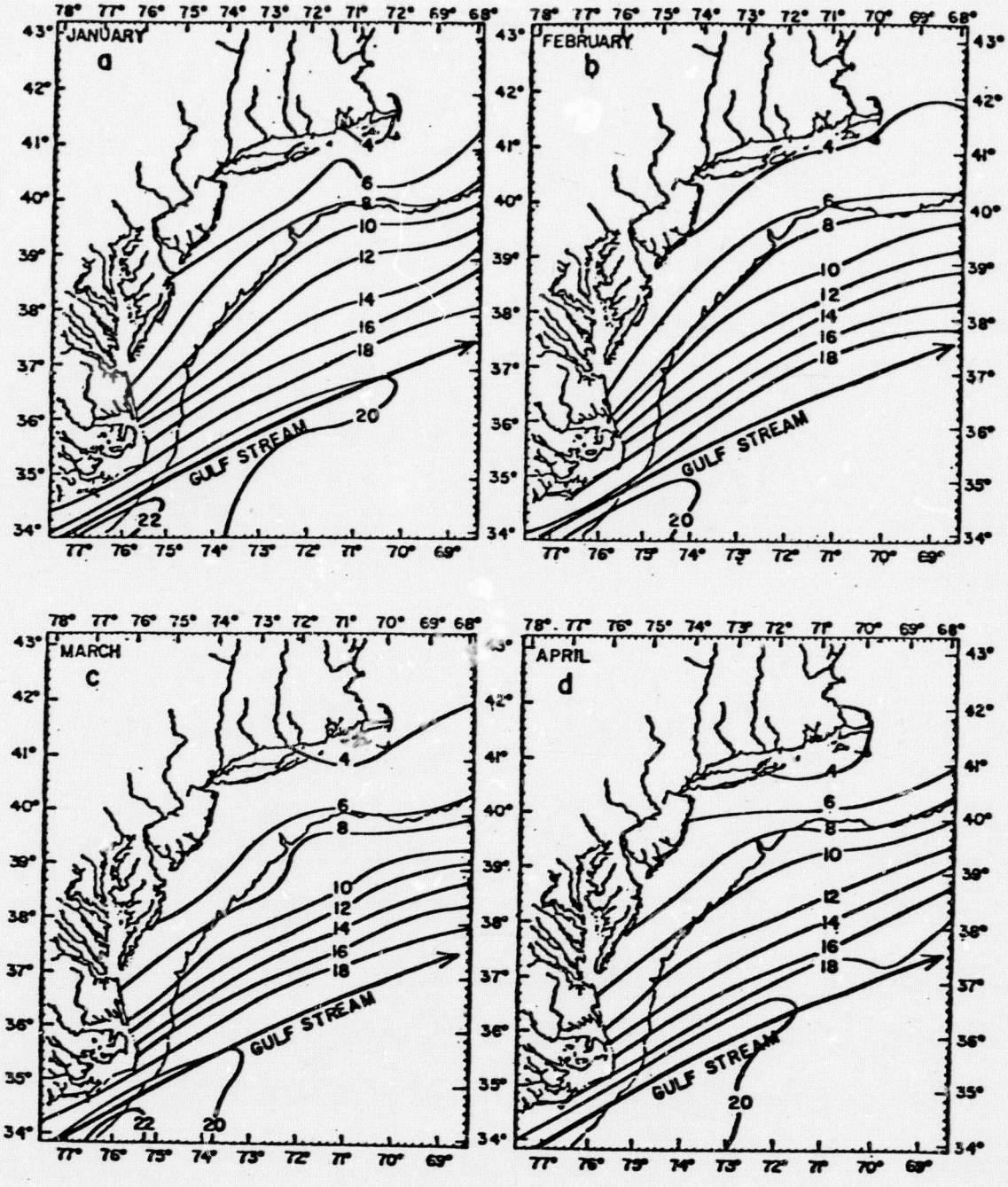

Figure II- 22 (a through d). Mean Sea Surface Isotherms, January-April (Gulf Stream refers to axis of mean current.) (Adapted from Havens et al., 1973)

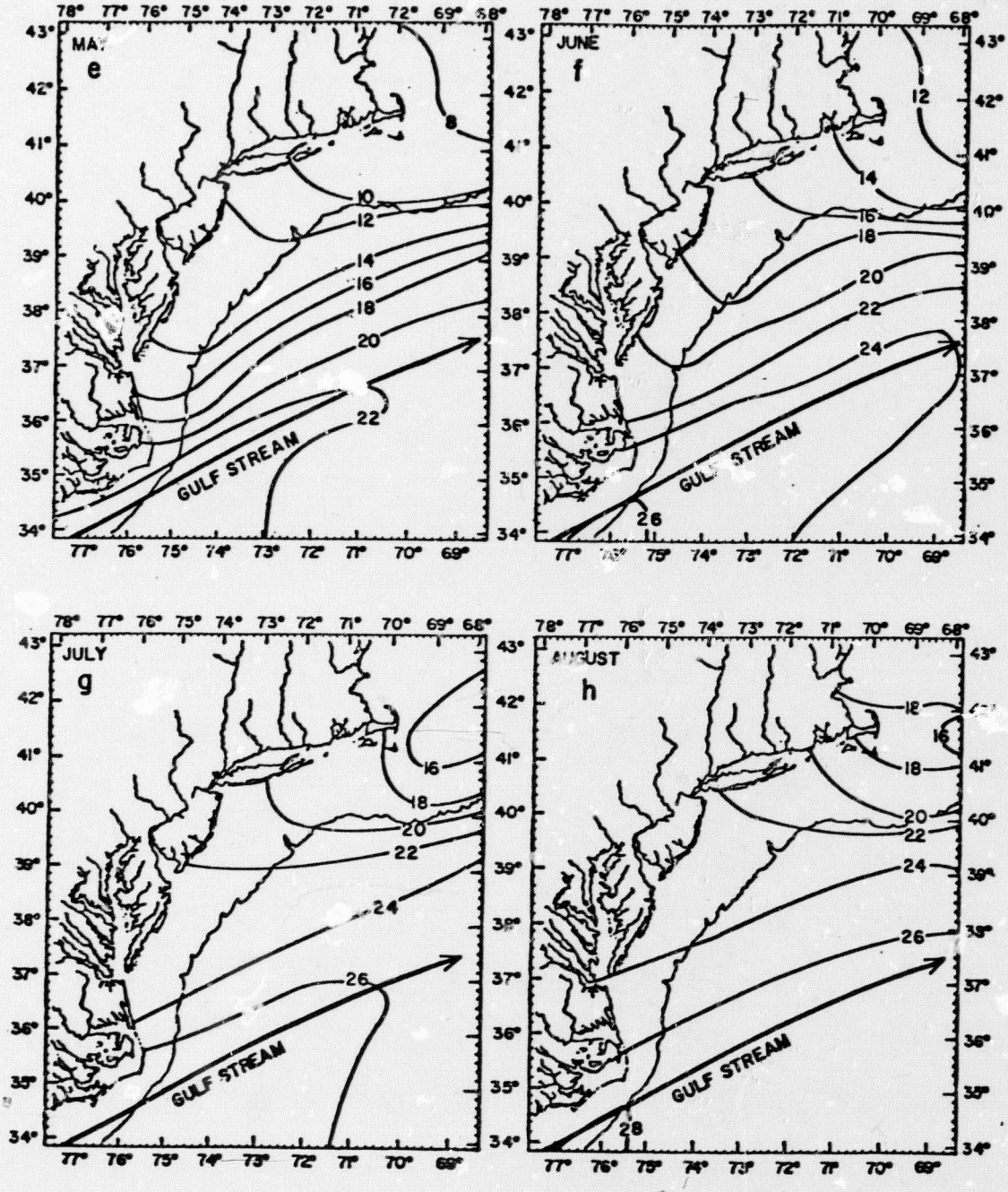

Figure II-22 (e through h). Mean Sea Surface Isotherms, May-August (Gulf Stream refers to axis of mean current.) (Adapted from Havens et al., 1973)

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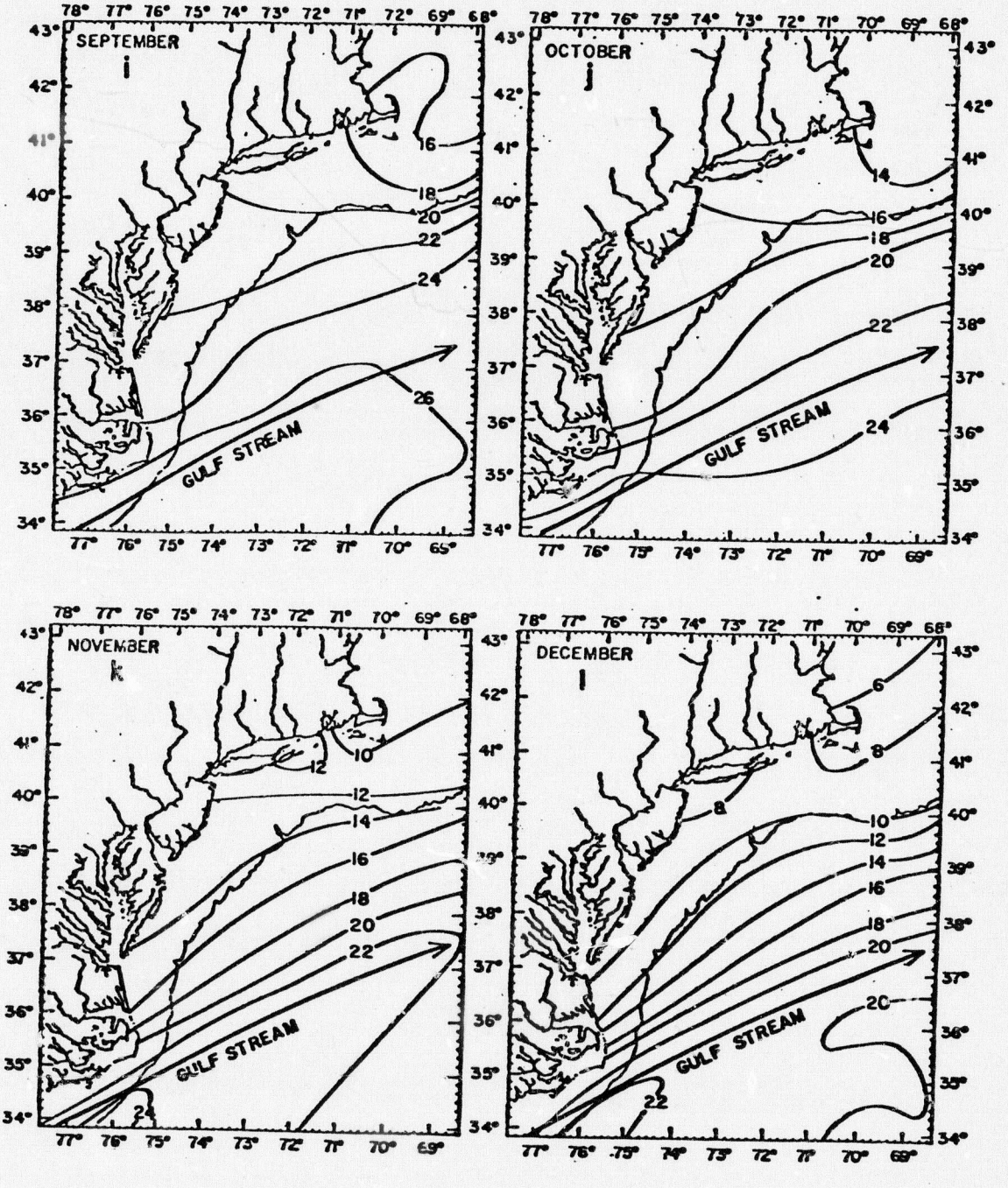

Figure II-22 (i through l). Mean Sea Surface Isotherms, September-December (Gulf Stream refers to axis of mean current.) (Adapted from Havens et al., 1973)

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a. Water Masses

Shelf Water

Shelf water is northern coastal water off Canada which moves in a southerly direction over the Continental Shelf. During this journey, it is continuously being modified by river runoff, land drainage, and the atmosphere (Fisher, 1973). In the winter, the salinities and temperatures are much lower than those of the slope water. In the summer, however, the surface temperature over the Continental Shelf may become indistinguishable from that of surface slope water; the salinity also increases over the shelf but remains lower than that of the slope water.

In his 1973 paper, Fisher attempts to describe shelf, slope and Gulf Stream water by temperature profiles. He states that while each water mass has a distinct thermohaline relationship, a temperature profile can be expected to provide a fairly accurate means of water mass identification. He also attempts to describe the shelf/slope and the slope/stream boundaries on the basis of temperature profiles. He states that strong fronts can occur at these boundaries which can be detected by horizontal temperature gradients. Mixing will occur across these fronts when either shelf water or Gulf Stream water overrides slope water or else when inversions occur.

Slope Water

Pelin, in 1936, defined slope water as a mixed zone for shelf water and Gulf Stream water. It is much more char-

acteristic of oceanic water than the previously discussed shelf water. In fact, Iselin found that below 200 m the average temperature-salinity curve of slope water is just slightly fresher than North Atlantic Central Water and at a depth of approximately 900 m the slope water becomes indistinguishable from North Atlantic Deep Water. In general, it can be said that the temperature-salinity characteristics of slope water fall between those of shelf and Gulf Stream water (McLellan, 1957). Fisher (1973) suggests that this water may circulate in a cyclonic gyre; he also states, however, that the surface circulation may be highly variable and a function of season just like the shelf water.

Gulf Stream

The Gulf Stream forms northwest of Little Bahama Bank and flows northward paralleling, to some degree, the continental margin. However, in the vicinity of Cape Hatteras it swings eastward away from the margin and heads towards Europe. Available data indicates that the Gulf Stream is a permanent feature whose flow exists throughout the year with no major directional shifts, although surface speeds vary on a seasonal basis from as little as 0.2 knots in winter to as high as 4.3 knots in summer (U.S. Naval Oceanographic Office, 1965). Information on fluctuations of the Gulf Stream is sparse but some data suggest that it meanders north and south of its axis. Eddies occasionally break off from the main body of the Gulf Stream and have been encountered in slope

water (Fisher, 1973). The subsurface portion of the Gulf Stream seems to have similar permanent features like the surficial portion, a deep countercurrent has been observed beneath the Gulf Stream (U.S. Naval Oceanographic Office, 1965).

b. Surface Circulation

Shelf Water

The surface circulation over the Mid-Atlantic Bight can be generally described in the following manner. In the vicinity of Long Island, the coastal drift current is in a southwestward direction curving southward along the coasts of New Jersey and the Delmarva Peninsula. It has a range in speed of between 5-20 cm/sec. As can be readily seen, the current tends to parallel the coastline. This situation, however, is a highly idealized picture of the general circulation and, in actuality, the true current patterns are much more complicated.

Bumpus (1973a) suggests that the surface circulation over the Mid-Atlantic Bight can be divided into a two-celled system (Figure II-23). The northern (or eastern) cell extends from Nantucket Shoals

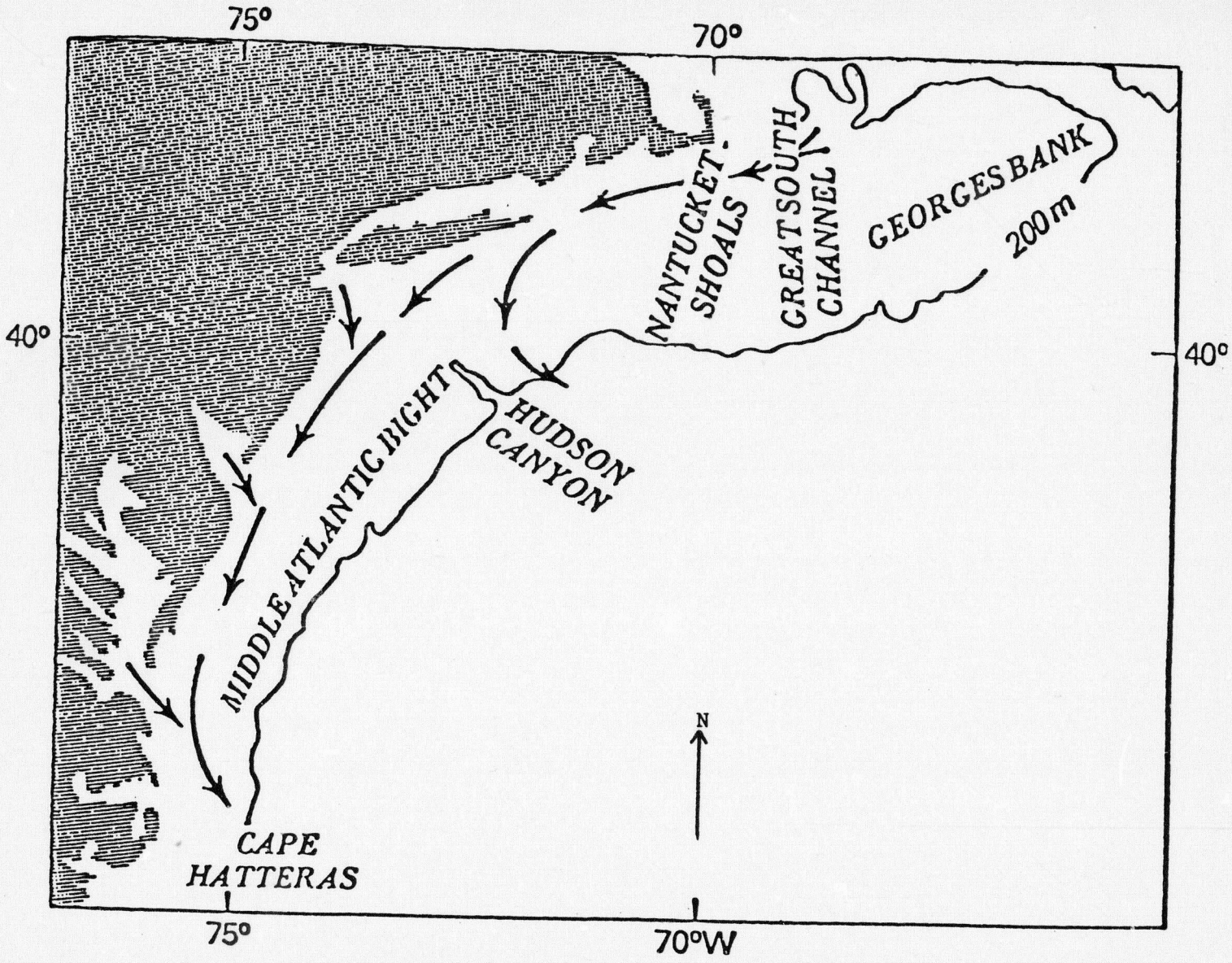


Figure II- 23. Two-celled Circulation Over the Mid-Atlantic Bight Inferred from Surface Drift Bottle Data by Bumpus
(Adapted from Bumpus, 1973a)

to the Hudson Canyon, while the southern (or western) cell extends from the Hudson Canyon to Cape Hatteras. During the spring, the northern cell receives indrafts from offshore south of Nantucket Shoals and from Georges Bank across South Channel. This water then moves towards Massachusetts and Rhode Island and then begins a southward flow. It eventually joins a compensating offshore drift which occurs east of the Hudson Canyon. Although this westerly drift is present, during the early months of the year the waters within the 90 m contour line are in a comparatively stagnant state. During this time of the year, the westerly drift can only be found beyond the 100 m line.

The southern cell, unlike the northern, experiences very few indrafts of water from offshore. The inflow to this cell comes primarily from rivers along the coast. It continues its flow in a southward direction down to Cape Hatteras. At this point, it turns to a seaward direction. Various dye experiments have been performed in the upper half of this southern cell. These experiments showed that, during the summer and autumn, weak cyclonic eddies exist near the New Jersey coast (Costin et al., 1973). It is maintained that these eddies aid in the transport of the low salinity Hudson-Raritan River effluent in a southerly direction.

During the months of April to September, it is possible that reversals in the surface current may occur (Bumpus, 1969). This could be a

result of a lower than usual river runoff occurring from March to May or else from southerly winds. These reversals can occur as far as 40 nautical miles from shore, but on the average occur at no greater distance than 30 nautical miles from shore. When reversals do occur salinities in the Bight show a marked increase. It is highly unlikely, however, for these current reversals to occur after the autumn due to the fact that the wind shifts to westerly and northwesterly directions.

Slope Water

At the present time, there is very little known about the circulation of the slope water which is located approximately along the shelf break. It is thought that on the shoreward side of the slope water mass, the currents flow in a southward direction to Cape Hatteras where they then turn seaward. Fisher (1973) suggests that the slope water may circulate in a cyclonic gyre with a range in speed of between 10-40 cm/sec. This theory appears to be borne out in the work of Morgan and Compton (1974). Their work, along with that of other investigators, also shows that at various times during the year a number of warm anticyclonic eddies may exist throughout the slope water though the general slope water circulation is cyclonic. These eddies are formed when a Gulf Stream meander becomes unstable, breaks off from the Gulf Stream, and then drifts into the slope water (Fisher, 1973).

Finally, it is known that exchanges between the shelf water and slope water occur in all seasons. Miller (1950) found major transfers occurring between the surface slope water and the shelf water south of Rhode Island along the 200 m contour line. Such transfers are caused by meanders similar to those of the Gulf Stream or else by the overrunning of slope water by shelf water. Also during summer, the slope/shelf boundary is marked by a temperature inversion near the shelf break. This inversion persists until mid-autumn, when a combination of diffusion and overturning destroys it.

c. Subsurface and Bottom Circulation

The subsurface and bottom circulation in the Mid-Atlantic Bight is even less well defined and less understood than that of the surface circulation. Bumpus (1973a) found that a variable residual drift exists along the bottom which at times may undergo a complete change of direction. Even though this current is variable, he nevertheless found that it still possessed a general tendency to flow in either a westerly or southerly direction at a rate of between 0.2-3.2 cm/sec. Bumpus also draws a line of divergence along the shelf bottom at the 60-70 m contour line. Shoreward of this line, besides its major southwesterly flow, the current also possesses an inshore component. South of Long Island, this inshore component tends to flow in a northwest

to northeast direction at a rate of between 1.1 and 1.9 cm/sec. Further south, it is found that this inshore flow converges on the coast of New Jersey down to the 38°30'N parallel. Below this latitude the bottom drift turns and flows towards the mouth of Chesapeake Bay. On the seaward side of the divergence line, the bottom drift has an offshore component beyond which very little else is known.

Beyond the shelf edge, it is believed that the bottom current flows in a southwesterly direction with the westerly component being extremely strong. The speeds range from 3 to 22 cm/sec (Warsh, 1974).

In regards to the vertical circulation, only a very few general comments can be made. It is known that some vertical mixing will occur during autumn when the vertical stability of the water column is reduced through surface chilling. More recently, Gordon and Girard (1973) found that the movement of water below the surface (1.0 m) often flows at an angle to the surface layer. They also found that the surface layer possesses Langmuir cells[1] on a scale of 3-9 m spacing. Although they believe that these Langmuir cells do not extend to the sea floor, they point out that these are just

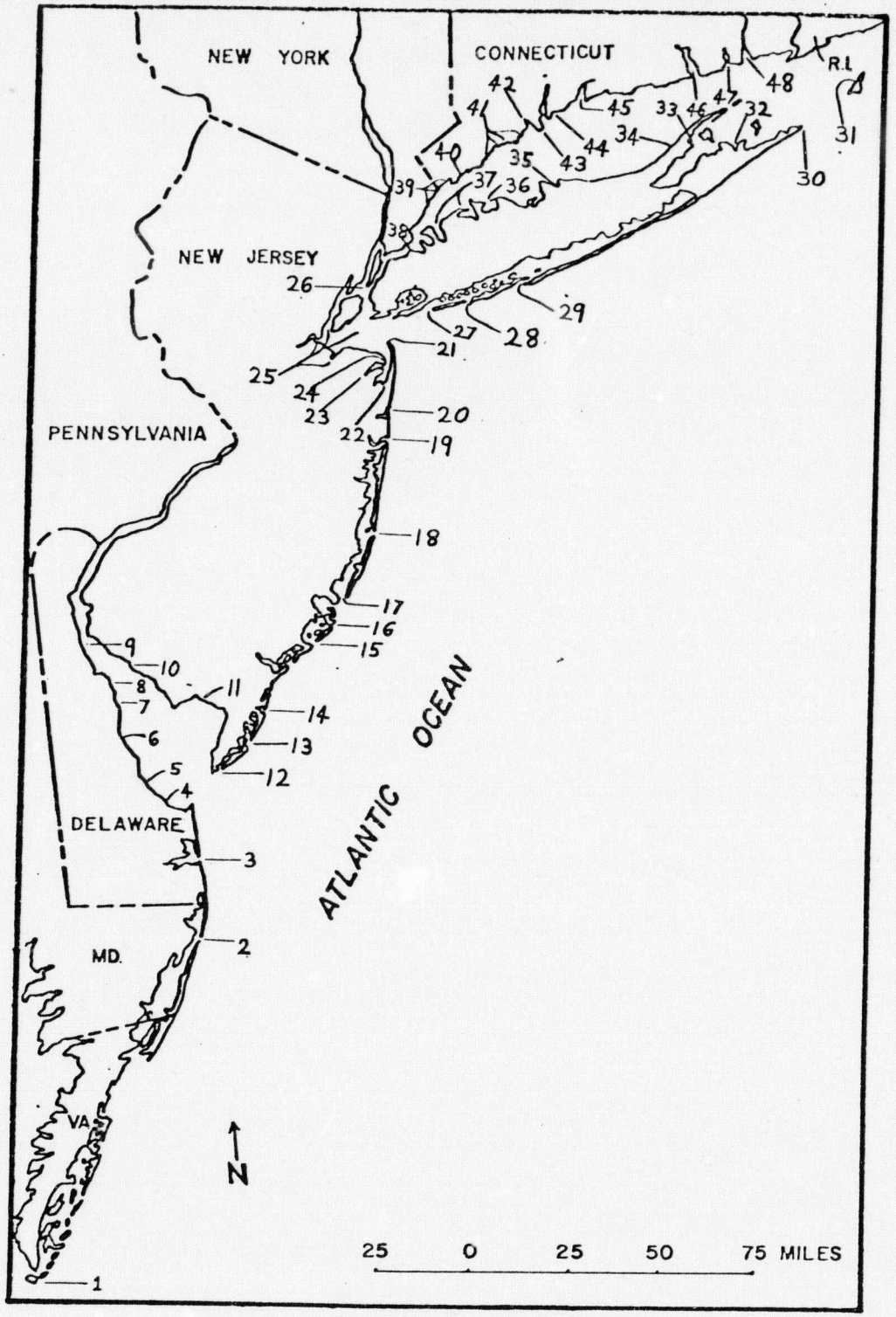
---

[1]The formation of windrows in surficial water layers (associated with wind shear motion).

basic findings and suggest various ways in which to improve the experimental procedures and thereby improve the results.

4. Tides and Tidal Currents

The tides along the Atlantic coast are a semidiurnal nature which means that, for every tidal day (24 hours and 50 minutes), there will be two high and two low waters. Slight differences in the range exist between any two given localities. Some examples of the tidal range variation along the Mid-Atlantic coast are: at Cape Charles the tidal range is 2.4 ft, at Cape May Harbor 4.4 ft, at Sandy Hook 4.6 ft, and at Montauk Point 2.0 ft (U.S. Department of Commerce, 1974, 1975) (Figure II-24 and Table II-10). In the open ocean, however, the actual rise of the tide induced wave crest is only on the order of one to two feet (Lynde, 1973). It is only when these waves move into shallower water that significant height variations can be detected (Lynde, 1973). The bottom topography not only affects the tidal range, but it also affects the times of high and low water (Redfield, 1958). Although the tides are primarily caused by the differences in the attractive forces of various celestial bodies (especially the moon and the sun) (Bowditch, 1966), daily meteorological conditions may also have an affect on them. Generally, onshore winds or a low barometer will cause heights of both the high and low water to be higher than usual, whereas offshore winds or high barometer will cause the reverse to be true (Lynde, 1973).



MID – ATLANTIC REGION

Figure II-24. Positions of Mean Tidal Ranges for Selected Mid-Atlantic Sites
(Source: U.S. Department of Commerce, 1974, 1975)

Table II-10. Mean Tidal Range for Selected Mid-Atlantic Sites

Position	Location	Mean Tidal Range (ft)
1	Cape Charles	2.4
2	Ocean City Inlet	3.4
3	Indian River Inlet	3.9
4	Roosevelt Inlet	4.4
5	Entrance to Mispillion River	4.6
6	Entrance to Murderkill River and St. Jones River	4.8
7	Entrance to Little River	5.4
8	Entrance to Leipsic River	5.5
9	Entrance to Smyrna River	5.8
10	Entrance to Cohansey River	6.0
11	Entrance to Maurice River	5.7
12	Cape May Harbor	4.4
13	Hereford Inlet	4.1
14	Townsend Inlet	3.8
15	Great Egg Harbor Inlet	3.8
16	Atlantic City	4.1
17	Beach Haven Inlet	3.7
18	Barnegat Inlet	3.1
19	Manasquan Inlet	4.0
20	Shark River Inlet	4.0
21	Sandy Hook	4.6
22	Branchport	1.7
23	Red Bank	3.0
24	Highlands	3.8
25	Keyport, Entrance to Passaic River, Arthur Kill, and Raritan Bay	5.0

Table II-10. Continued.

Position	Location	Mean Tidal Range (ft)
26	Battery	4.5
27	Rockaway Inlet	5.0
28	East Rockaway Inlet	4.1
29	Jones Inlet	4.0
30	Montauk Point	2.0
31	Great Salt Pond (New Harbor)	2.6
32	Three Mile Harbor	2.4
33	Shelter Island Sound	2.5
34	Mattituck Inlet	5.0
35	Port Jefferson Harbor	6.6
36	Huntington Bay	7.4
37	Oyster Bay, Hempstead Harbor	7.3
38	Willets Point	7.1
39	Mamaroneck Harbor, Port Chester, Captain Harbor	7.3
40	Stamford Harbor	7.2
41	Five Mile River, Norwalk River, Saugatuck River, Southport Harbor	7.0
42	Pequonnock River	6.7
43	Stratford	5.5
44	The Gulf	6.6
45	New Haven Harbor	6.2
46	Saybrook Jetty	3.5
47	Niantic Bay	2.7
48	New London	2.6

(Source of Data: U. S. Department of Commerce, 1974, 1975)

Also, at certain times of the year, higher than average tides (spring tides) and smaller than average tides (neap tides) will occur. These will take place during full and new moons and first and third lunar quarters respectively (Figure II-25).

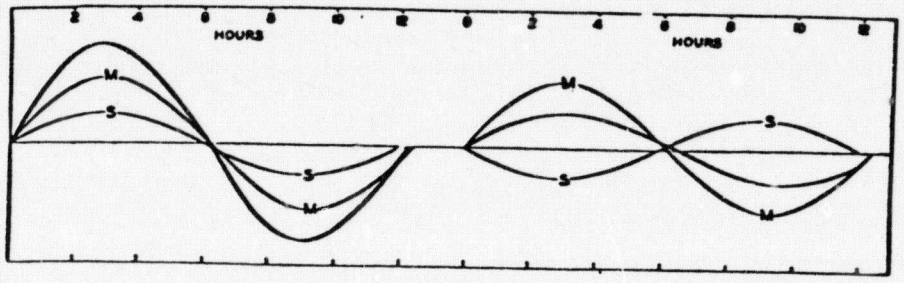


Figure II-25. Tide Curves at Spring Tide (Left) and Neap Tide (Right), Where m Refers to the Moon and s Refers to the Sun. (Adapted from Sverdrup, Johnson, and Fleming, 1942)

During the occurrence of a storm, an event known as "storm surge" or "meteorological tide" or "storm tide" may occur. This is nothing more than the difference between the observed tide and the normally occurring tide (Figure II-26). It is primarily caused by the piling up of water against the coasts by the action of the wind (Neumann and Pierson, 1966). This action is also known as Windstau. In

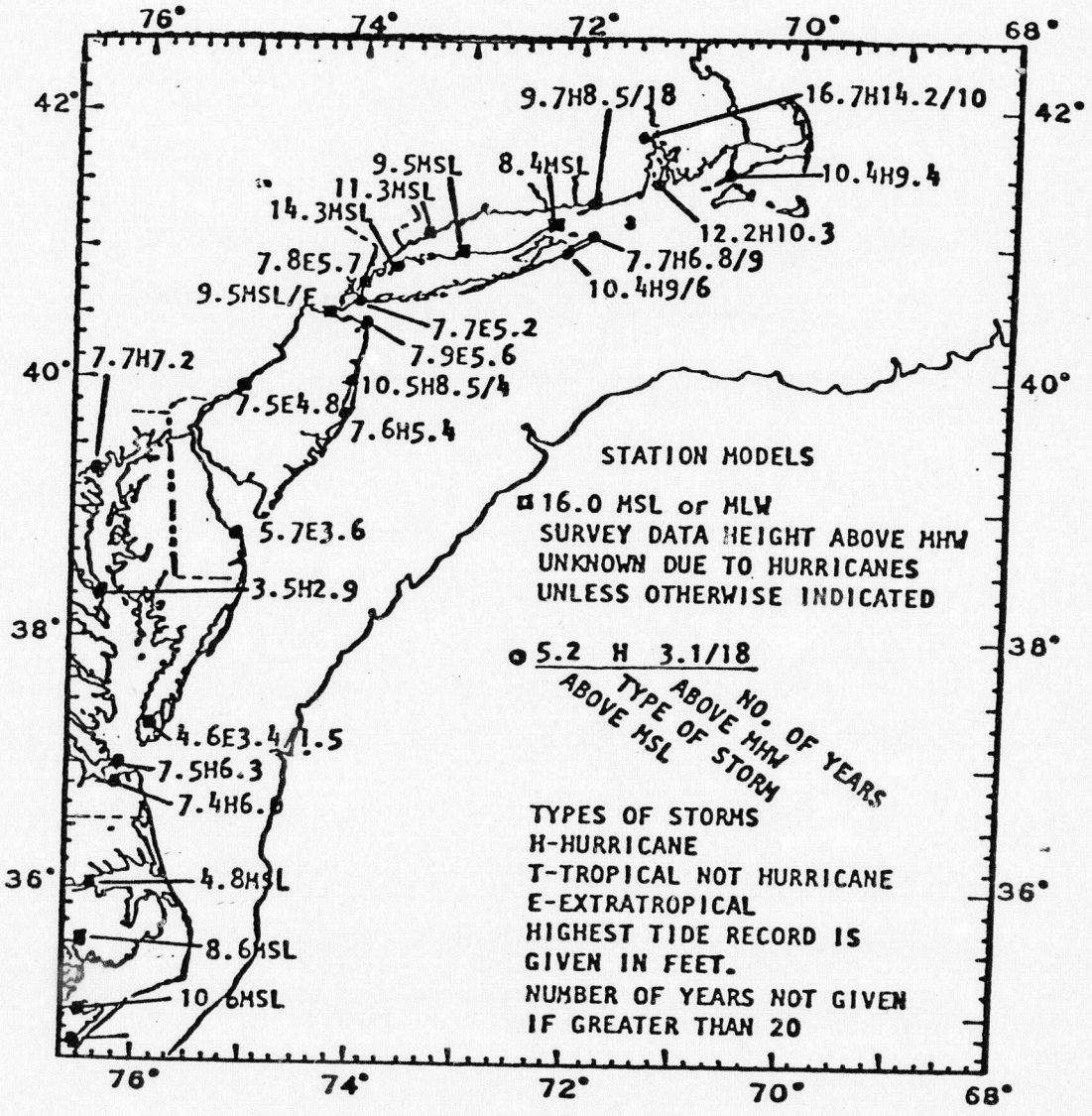


Figure II-26. Highest Recorded Tide Levels
(Adapted from Lynde, 1973)

addition to Windstau, storm surge is also affected by the coastline configuration and bathymetry, the transport of water by sea and swell in the nearshore shallow areas (Harris, 1963) and a reduction of atmospheric pressure. According to Bowditch (1966), such tides may begin when the storm center is 500 miles or more from the shore and will gradually increase until the storm passes. He also states that the highest storm tides are caused by a slow moving tropical cyclone of a large diameter because both of these effects result in a greater duration of the wind in the same direction.

Tides, which are defined as the vertical movement of water, are accompanied by tidal currents which are the horizontal movement of water. Since tidal currents are also caused by the attraction of celestial bodies, they are periodic in nature. It is this periodicity which distinguishes them from the other currents found in the sea. In narrow areas, such as rivers and bay entrances, these currents can attain considerable velocity. Over the Mid-Atlantic Continental Shelf, however, they are generally less than 0.1 knot and continuously change direction (Bumpus, 1973b). They rotate clockwise so that on the average, in 12 hours and 25 minutes, their direction will have rotated a full 360 degrees.

5. Sea and Swell

Sea and swell are the terms which are normally used when referring to the condition of the ocean's surface or, in other words, the sea state. Sea primarily refers to waves which have been generated and are still under the influence of local winds. According to Shaw (1973), these waves are highly irregular in shape and have sharp angular unaligned crests. They also have a very variable height when examined over a small area. Swell, on the other hand, refers to waves which have travelled out of their area of generation and are no longer under the influence of the local winds. Unlike sea waves, swell waves are very regular and are all of about the same height with aligned crests (Shaw, 1973).

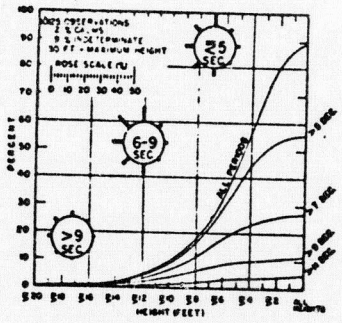
In the Mid-Atlantic Bight, the local winds, the land boundaries, the Continental Shelf width, and the bottom topography (especially the Hudson Canyon) all have a major influence upon the waves which are formed. A northwest wind, for example, will not generate waves of any significant size due to the location of the land boundaries. A northeast wind, however, will generate waves which will gradually increase in size as one moves southward. This is due to the "increasing" width of the Continental Shelf. In regards to wave refraction or "bending," bottom topgraphy plays a major role (Goldsmith et al., 1974). According to Chao (1974), this is extremely important in shoaling water. He defines shoaling water as a water depth less than half of the wave length and further

states that wave refraction may cause a marked change in wave height, as well as a change in direction of travel.

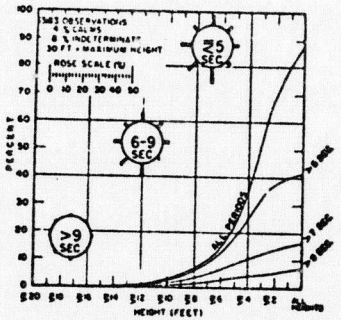
Figure II-27 shows wave period-height and period-direction graphs for a sea region which includes the potential lease tracts. As can be seen, the majority of all waves have periods less than 7 seconds with directions primarily from onshore.

Figures II-28a to II-28c present percentage frequency lines for waves greater than or equal to a height of 5 feet and 12 feet respectively. Upon examining these figures, it can be seen that the waves tend to follow the local wind patterns over the area, as should be expected. The winds (and therefore the waves) normally come from the west with a slight shift to the northwest during the winter and to the southwest during summer. It can also be seen, from Figures II-28a to II-28c, that as one goes farther from shore the wave height increases. This is characteristic of the much "stormier" weather which is present over the open ocean rather than near the shore.

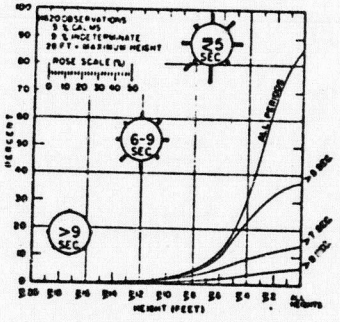
During the winter months (December, January, and February), about 2 percent of the time, waves with heights greater than 20 feet can be expected. The median significant wave height (the 50th percentile) is approximately 4 feet during the winter and 2 feet during



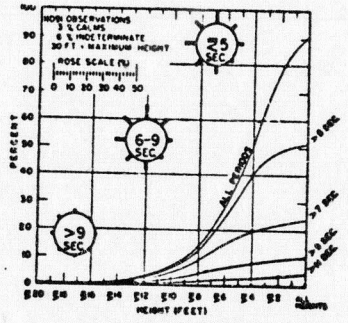
WINTER
(JAN. FEB. MAR.)



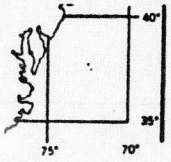
SPRING
(APR. MAY JUN.)

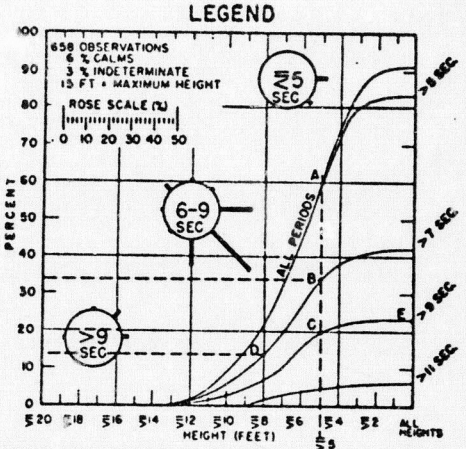


SUMMER
(JUL. AUG. SEP.)



AUTUMN
(OCT. NOV. DEC.)

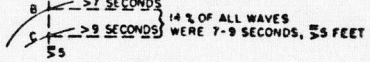




A POINT ON THE GRAPH SHOWS THE PERCENTAGE OF ALL WAVES OBSERVED WITH PERIODS EXCEEDING, AND HEIGHTS EQUAL TO OR EXCEEDING, CERTAIN VALUES

POINT A 60 % OF ALL WAVES WERE ≥5 FEET
- B 34 % OF ALL WAVES WERE >7 SECONDS, ≥5 FEET
- E 23 % OF ALL WAVES WERE >9 SECONDS

AN INTERVAL BETWEEN TWO POINTS OF THE SAME HEIGHT CATEGORY SHOWS THE PERCENTAGE OF ALL WAVES OF THAT HEIGHT CATEGORY WITHIN A CERTAIN RANGE OF PERIODS



AN INTERVAL BETWEEN TWO POINTS ON THE SAME PERIOD CURVE SHOWS THE PERCENTAGE OF ALL WAVES REPRESENTED BY THE CURVE WITHIN A CERTAIN RANGE OF HEIGHTS:

AN ARM OF A ROSE INDICATES THE PERCENTAGE OF ALL OBSERVATIONS WHICH ARE IN THE GIVEN PERIOD-DIRECTION CATEGORY:

25% OF ALL WAVES OBSERVED HAD PERIODS OF 6-9 SECONDS AND CAME FROM THE SOUTHEAST.

15 % OF ALL WAVES OBSERVED CAME FROM THE SOUTH. 12% OF THESE WAVES HAD PERIODS OF 6-9 SECONDS AND 3% HAD PERIODS >9 SECONDS.

Figure II-27 . Wave Period-Height and Period-Direction Graph for Mid-Atlantic OCS. (U.S. Department of Commerce, 1973)

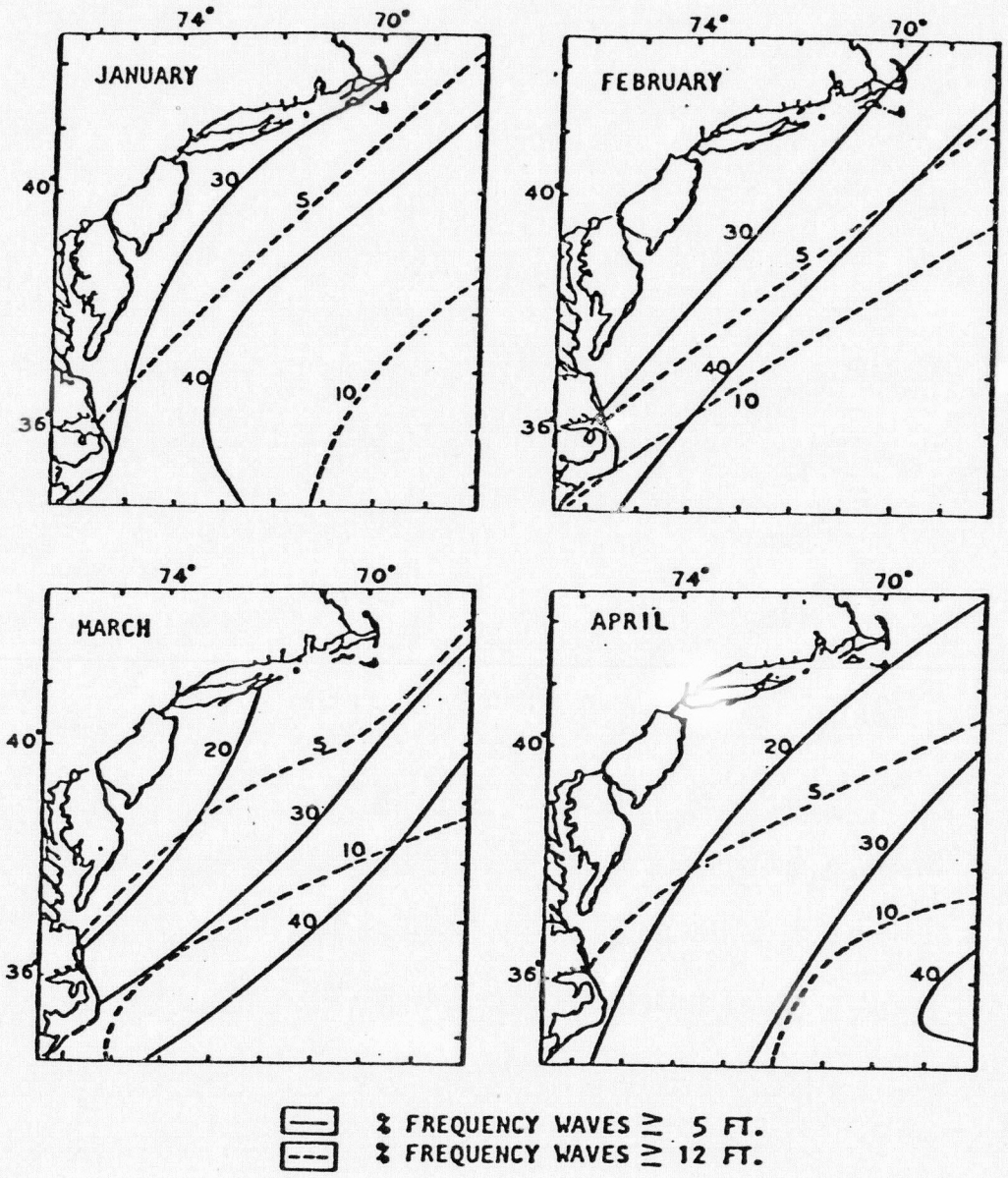


Figure II-28a. The Percentage Frequency of Waves Equal to or Greater than 5 Feet (Solid Lines) and Equal to or Greater than 12 Feet (Dashed Lines) by Month (January-April)
(Adapted from Shaw, 1973)

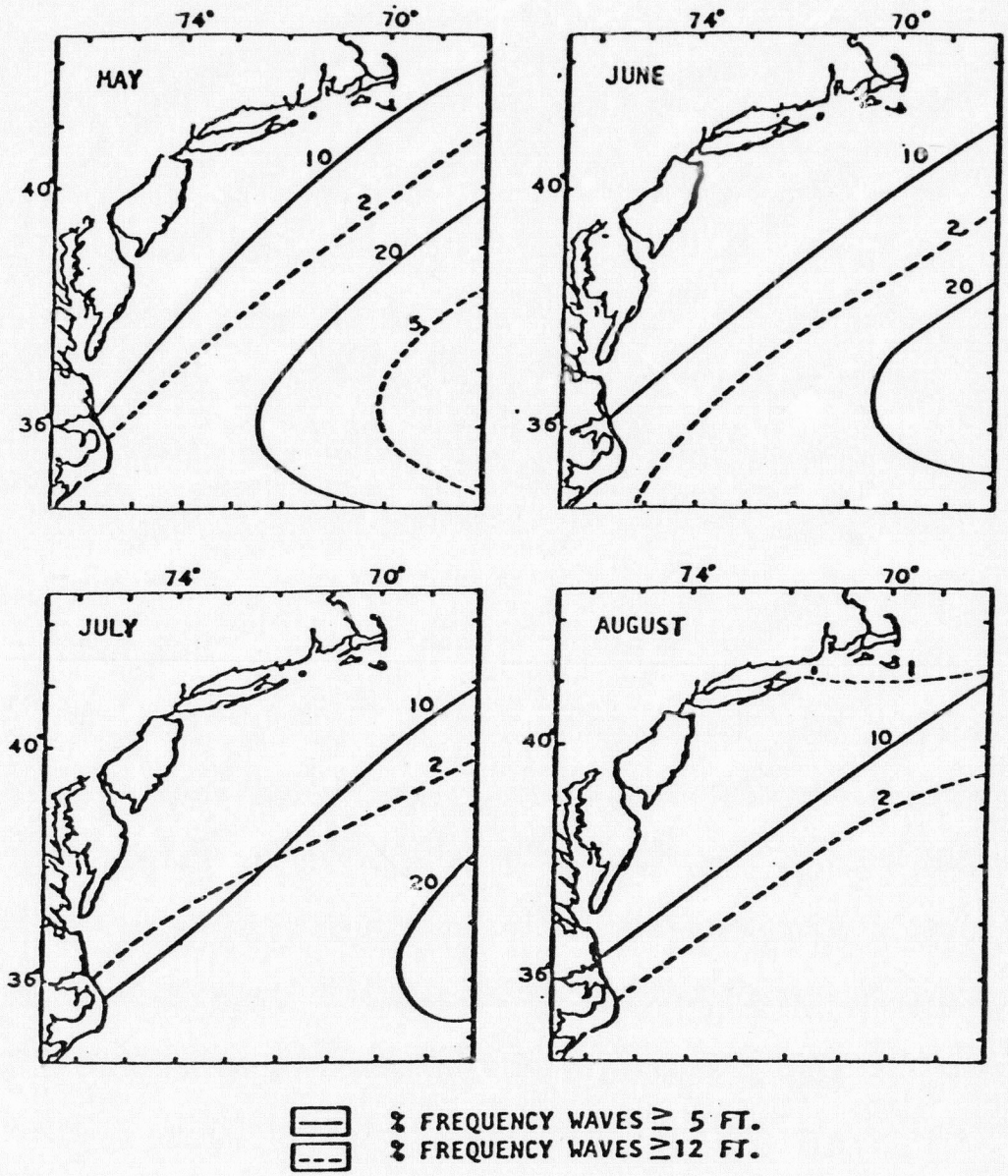


Figure II- 28b. The Percentage Frequency of Waves Equal to or Greater than 5 Feet (Solid Lines) and Equal to or Greater than 12 Feet (Dashed Lines) by Month (May-August)
(Adapted from Shaw, 1973)

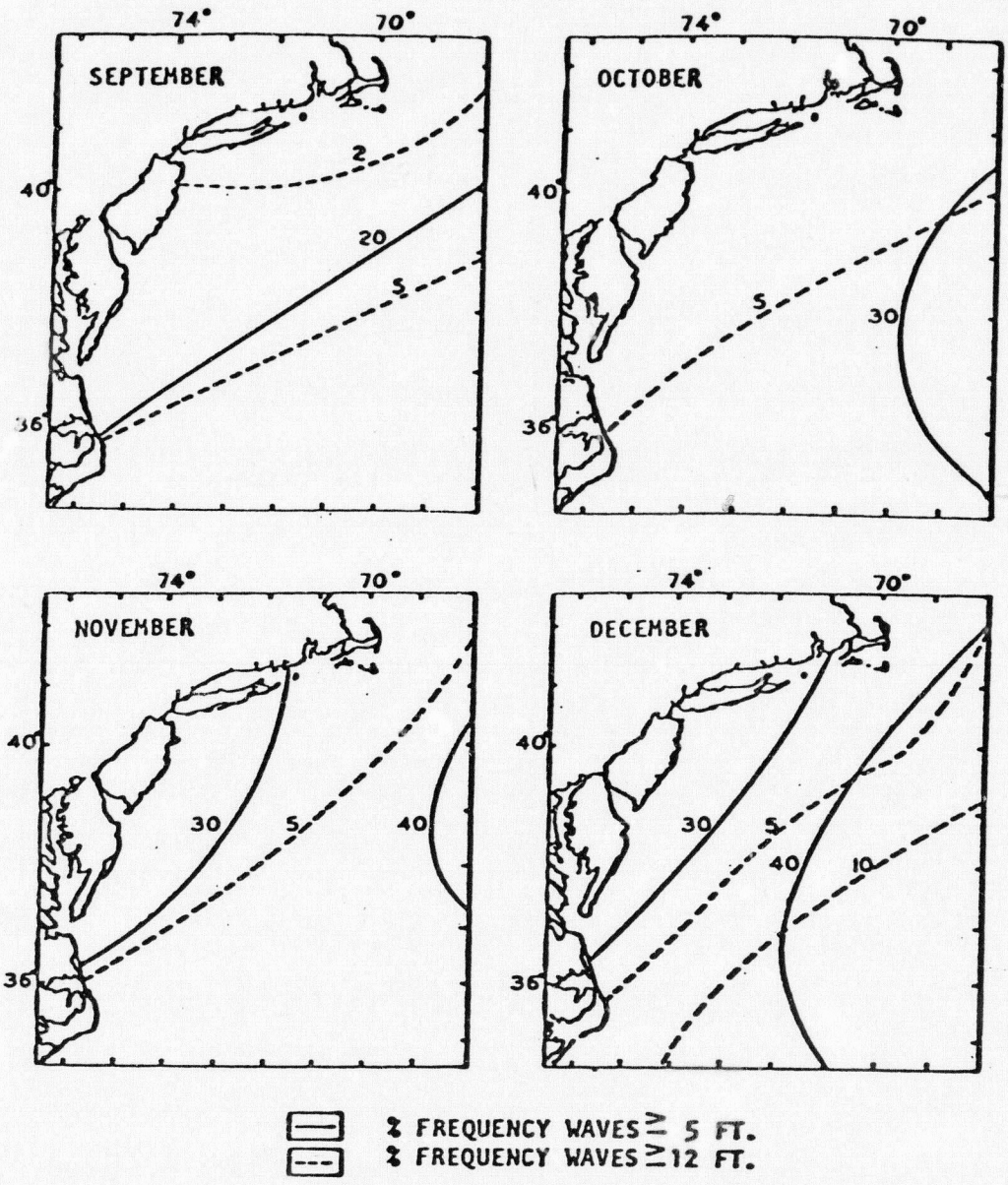


Figure II- 28c The Percentage Frequency of Waves Equal to or Greater than 5 Feet (Solid Lines) and Equal to or Greater than 12 Feet (Dashed Lines) by Month (September-December)
(Adapted from Shaw, 1973)

the summer. These relatively low wave heights, however, do not eliminate the possibility of exceptionally high waves. In fact, according to Tetra Tech (1974), once every five years a maximum wave height of 73 feet can be expected, while once every one hundred years one of 103 feet can be expected.

6. Ice

The occurrence of icebergs in the Mid-Atlantic area is extremely rare, with the last one being sighted in January 1916. This was a 30 ft piece of hummocked ice 2 ft high located at 33°N, 71°00'W which is far south of the proposed sale area. It should be noted that this sighting is not recognized by the International Ice Patrol. Their last recorded sighting occurred in August 1915 at 40°46'N, 68°24'W which is far east of the area of interest (Havens et al., 1973). This sighting was a growler, which is a medium sized piece of ice, smaller than 5 m high and of a size less than a small cottage (Baker et al., 1966). It can therefore be concluded that icebergs should not present a major problem in the area of the proposed lease sale.

Bay ice, on the other hand, having a concentration of at least one-tenth coverage, will occur in many of the bays and inlets along the East Coast from December to March (Havens et al., 1973). Although the greatest extent of coverage occurs during February, the overall conditions vary greatly on a yearly basis.

Bay ice, however, will not present a problem in the area of activities that would be involved in this proposed action.

7. Drowned River Mouths

Within the Mid-Atlantic area, three major estuarine areas are found: Raritan Bay, Delaware Bay, and Chesapeake Bay. These bays are drowned river mouths; a drowned river mouth being the lower end of a river that has been widened or submerged by an invasion of seawater along the coast (Gray et al., 1974).

a. Raritan Bay

Raritan Bay (including Lower New York Bay and Sandy Hook Bay) is found in the northwest corner of the Mid-Atlantic Bight. It is triangular in shape and is approximately 13 nautical miles long on its east-west axis and almost 12 miles long on its north-south axis (Bumpus, 1973b). Excluding Lower New York Bay, it occupies 1.67×10^9 sq ft (Jeffries, 1962) or approximately 50 sq miles. It is a relatively shallow area with depths of 22 ft and 28 ft being found in Raritan Bay proper and Lower New York Bay respectively. The mean tidal ranges are 5.0 ft at the Passaic River, the Arthur Kill, and Raritan Bay proper; 4.6 ft at Sandy Hook; and 4.5 ft at the Battery. The river discharge into this area is 26,400 cubic ft/sec on the average (Bue, 1970) and has a flushing rate of 15 to 30 days (Ketchum, 1951). The tidal currents range from weak and variable to almost 1 knot in Raritan Bay proper and 0.5 to 3 knots in the main ship channel and the Narrows (Bumpus, 1973b).

For wind-induced currents, the maximum velocity which is most probable in 1.5 knots under storm conditions (Brower et al., 1972). North of Sandy Hook, the circulation flows in a cyclonic gyre in the southern half of the bay, while in the northern half a south-easterly flow into the New York Bight predominates (Smayda, 1973). In 1972, Brower et al. used statistical methods to determine various parameters due to a lack of actual observations. They found that once every 5 years a 69 knot wind and a 20 ft wave could be expected to occur in Raritan Bay, while once every 50 years a 92 knot wind and a 35 ft wave could be expected.

Water temperature in the bay has an annual range of 21°C, with values of less than 3°C occuring in the winter and greater than 24°C in the summer. The horizontal variation is approximately 2°C, while the vertical variation is only 1°C (Bumpus, 1973b). In regards to salinity, Raritan Bay has a range of between 11°/oo to 27°/oo. The horizontal variation ranges from less than 3°/oo in the summer to greater than 10°/oo in the winter. This variation is primarily due to river runoff which will also affect the vertical gradient (Bumpus, 1973b).

Finally, for further information regarding various environmental parameters, the reader is referred to Table II-11 (Parts I-III).

ENVIRONMENTAL DATA SUMMARY (PART 1)

AREA: Raritan Bay

ENVIRONMENTAL FACTORS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
WIND SPEED (KNOTS)													
01% ≤	2	2	2	3	2	1	1	2	2	2	2	3	2
Mean	11.4	11.5	12.2	11.4	10.0	9.7	9.2	8.8	9.4	9.7	10.5	10.9	10.4
99% ≤	35	32	32	36	32	28	31	29	28	34	31	31	32
Maximum observed (1871 - 1971)	Winds near 100 knots have probably occurred during the passage of Tropical Cyclones.												
≥ 34 Knots (% freq.)	1.2	0.1	0.1	1.3	+	+	+	+	0.1	1.3	0.1	+	0.4
≥ 41 Knots (% freq.)	+	+	+	+	+	+	0.0	0.0	+	+	0.1	+	+
Prevailing direction	WNW	NW	NW	S	S	S	S	S	S	SW	WSW	WSW	S
WAVES (FEET)													
01% ≤	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	3	3	3	2	2	2	2	2	3	2	2	2	2
99% ≤	9	8	8	8	8	8	6	8	7	6	8	6	7
≥ 12 Feet (% freq.)	+	+	+	+	+	0.0	0.0	0.0	+	+	+	0.0	+
≥ 20 Feet (% freq.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	+	0.0	+
VISIBILITY (% FREQ.)													
Visibility <½ N. mile	2.5	2.2	1.4	1.8	1.7	1.4	0.7	0.8	0.4	0.9	1.2	1.7	1.4
Visibility <1 N. mile	4.4	3.7	3.2	3.0	2.9	2.4	1.3	1.1	1.0	1.7	2.2	3.4	2.5
Visibility <2 N. miles	7.4	7.1	5.3	4.8	5.3	4.9	3.5	3.0	2.7	3.3	4.4	6.4	4.9
Visibility <5 N. miles	22.1	20.6	15.0	14.8	17.4	18.9	19.3	19.5	14.3	16.6	17.9	21.1	18.1
Visibility <10 N. miles	51.4	46.5	39.1	40.5	42.4	49.0	53.9	51.8	42.8	44.6	45.8	53.5	46.8

+ = less than 0.05%

Table II-11. Environmental data summary: Raritan Bay area. (Adapted from Brower et al., 1972)

ENVIRONMENTAL DATA SUMMARY (PART 2)

AREA: Raritan Bay

ENVIRONMENTAL FACTORS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
FOG													
Occurrence of fog (% freq.)	11.5	11.3	10.7	11.2	11.2	10.0	7.0	7.8	6.5	7.0	9.0	11.2	9.5
Mean number of hours operation of fog signals *	40	34	29	40	45	43	29	18	17	22	29	34	380
Maximum number of hours operation of fog signals for any year (annual only)*													578
WEATHER & CLOUDS (% FREQ.)													
Precipitation	15.0	15.1	16.4	14.9	11.3	7.9	6.9	7.5	7.9	8.7	11.2	14.5	11.4
Freezing precipitation	0.6	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
Frozen precipitation	4.8	5.5	4.8	0.6	+	+	0.0	0.0	0.0	0.1	0.7	3.8	1.7
Thunder & lightning	0.0	0.0	0.1	0.2	0.6	0.8	1.1	0.7	0.3	0.1	0.0	0.0	0.3
Sky ≤2/8	35.9	36.9	38.2	33.7	33.2	37.0	36.0	38.4	43.7	47.2	40.4	38.9	38.3
Sky overcast (8/8)	44.1	42.0	40.6	40.3	37.0	30.7	28.9	29.7	28.7	29.6	36.3	40.1	35.6
Sky obscured	9.9	15.4	11.2	13.8	20.9	15.8	11.0	8.9	4.0	4.4	3.0	4.8	10.0
Low cloud overcast	24.2	22.0	22.8	19.2	16.0	14.5	15.3	13.6	14.8	14.9	20.4	22.3	18.4
Mean cloud cover (eighths)	4.8	4.7	4.6	4.9	4.8	4.5	4.6	4.4	4.1	3.8	4.4	4.6	4.5
AIR TEMPERATURE (°F)													
Minimum	-6	-15	3	12	31	44	52	46	39	28	5	-13	-15
01% ≤	12	11	21	30	45	55	61	61	53	39	27	16	36
Mean	33.6	33.5	40.0	49.8	59.9	69.4	75.1	73.9	67.5	57.8	47.3	36.5	54.0
99% ≤	49	47	61	69	79	83	88	87	83	73	62	51	70
Maximum	72	75	86	92	99	101	106	104	102	94	84	70	106
≤ 32 °F (% freq.)	62.7	67.1	42.6	5.8	0.1	0.0	0.0	0.0	0.0	0.3	14.0	52.6	20.4
≥ 85 °F (% freq.)	0.0	0.0	+	+	0.5	0.9	6.8	3.7	0.3	+	0.0	0.0	1.0

* West Bank fog Signal

+ = less than 0.05%

Table II-11. Continued

ENVIRONMENTAL DATA SUMMARY (PART 3)

AREA: Raritan Bay

ENVIRONMENTAL FACTORS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
RELATIVE HUMIDITY (%)													
Mean	69	67	67	68	70	71	72	73	72	70	69	69	70
SEA TEMPERATURE (°F)													
Minimum	28	27	27	35	46	51	63	65	56	41	32	28	27
01% ≤	29	29	33	38	49	54	64	67	59	51	42	32	45
Mean	38.5	37.0	39.6	46.3	55.3	65.2	71.8	72.9	69.3	60.7	51.8	43.1	54.3
99% ≤	50	52	54	59	72	78	80	82	81	72	61	53	66
Maximum	54	56	59	64	81	83	85	87	86	78	67	63	87
SALINITY (‰)													
Minimum	5.6	10.1	4.2	1.7	2.0	3.9	11.4	11.6	5.9	7.5	9.9	5.6	1.7
Mean	22.0	22.5	20.2	19.1	20.8	22.7	24.5	24.8	25.0	24.8	23.7	22.8	22.7
Maximum	28.6	29.3	28.4	[illegible]	28.0	29.3	30.7	30.2	31.2	32.9	29.1	31.1	32.9
DENSITY (ρ)													
Mean (σ_t)*	16.3	16.5	14.8	14.0	15.2	16.6	17.9	18.3	18.4	18.3	17.4	16.8	16.7
SEA-LEVEL PRESSURE (mb)													
Minimum	978	971	983	985	995	992	994	977	992	995	989	983	971
01% ≤	992	983	990	991	1000	1002	1001	1002	1001	999	992	993	996
Mean	1016	1016	1015	1015	1014	1014	1015	1015	1018	1018	1018	1019	1016
99% ≤	1039	1040	1035	1034	1030	1031	1031	1029	1034	1036	1039	1040	1035
Maximum	1042	1042	1041	1035	1032	1035	1032	1032	1037	1040	1041	1041	1042

* $\sigma_t = (\rho - 1) \times 10^3$; ρ = gm cm^{-3}

Table II-11. Continued

b. Delaware Bay

Delaware Bay is located on the western side of the Mid-Atlantic Bight between New Jersey and Delaware. It is somewhat teardrop in shape and is approximately 41 nautical miles long and almost 24 nautical miles at its widest part (Bumpus, 1973b). It occupies an area of almost 20.07×10^9 sq ft or 720 sq miles, with its upper limit set at approximately 75 km inland (Shuster, 1959). It has an average depth of 32 ft and a maximum depth of 150 ft. The mean tidal ranges are 5.7 ft at the Maurice River entrance, 6.0 ft at the Cohansey River entrance, 5.8 ft at the Smyrna River entrance, 5.4 ft at the Little River entrance, 4.6 ft at the Mispillion River entrance, and 4.4 ft at Roosevelt Inlet (U.S. Department of Commerce, 1974). The river discharge into the bay is approximately 21,000 cubic ft/sec (Bue, 1970) and has a flushing rate of 40.9 to 89.5 days (Ketchum, 1952). The tidal currents range from 0.4 to 3 knots between the Capes, 0.5 to 2 knots in the lower part of the bay, and 0.5 to 3 knots in the upper part (Bumpus, 1973b). For wind induced currents, velocities of 1.8 knots were found in the Delaware Bay channel (Brower et al., 1972). According to Klemas et al. (1974), there is a large rotary current that normally flows southward along the western edge and northward along the eastern edge of Delaware Bay. The northerly and southerly flows are reinforced by the flood tide and ebb tide respectively.

As with Raritan Bay, Brower et al. (1972) used statistical methods to determine various parameters for Delaware Bay due to a lack of actual observations. He found that once every 5 years a 63 knot wind and a 20 ft wave could be expected to occur, while once every 50 years a 92 knot wind and a 35 ft wave could be expected (similar to Raritan Bay).

The mean water temperature for the bay is 12.8 °C, with a minimum value of -2.2 °C and a maximum value of 32.2 °C, occurring in the winter and summer respectively (Brower et al., 1972). The salinity increases from 0 o/oo at the river mouth to about 32 o/oo at the Capes. However, these salinities are highly dependent upon river flow. Also, there is an up-estuary movement in the lower layers of water and a down-estuary movement in the surface layers, thereby setting up a two-layer system (Bumpus, 1973b). In 1957, Hulburt found small vertical differences (less than 2 o/oo) in salinity during the autumn but rather large ones (almost 15 o/oo) during the spring. In addition, Table II- 12 (Parts I-III) presents additional information in regards to other environmental parameters.

c. Chesapeake Bay

The following discussion on Chesapeake Bay is taken from Bumpus et al. (1973a):

Chesapeake Bay, the major laboratory for the generation of the concepts about coastal plain estuaries through the research of the Chesapeake Bay Institute, is located off the westernmost part of the Middle Atlantic Bight at 37-39°N, 76°W. The bay, with its

ENVIRONMENTAL DATA SUMMARY (PART 1)

AREA: Delaware Bay

ENVIRONMENTAL FACTORS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
WIND SPEED (KNOTS)													
01% ≤	2	2	2	2	2	2	1	1	1	2	2	3	2
Mean	11.1	11.2	11.3	10.4	9.0	8.3	7.9	7.8	8.5	9.2	10.2	10.3	9.6
99% ≤	37	35	37	32	25	24	22	22	24	33	36	36	30
Maximum observed (1871 - 1971)	Winds near 90 knots have probably occurred over Delaware Bay												
≥ 34 Knots (% freq.)	2.7	2.5	1.8	0.8	0.2	0.1	0.2	0.3	0.5	1.0	1.4	1.8	1.1
≥ 41 Knots (% freq.)	0.7	0.7	0.5	0.3	0.1	0.1	0.1	0.1	0.1	0.2	0.4	0.5	0.3
Prevailing direction	NW	NW	NW	NW	SW	SW	SW	SW	S	N	NW	W	W
WAVES (FEET)													
01% ≤	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	3	3	3	2	2	2	1	1	2	3	3	3	2
99% ≤	11	10	10	9	9	8	7	6	8	9	10	10	9
≥ 12 Feet (% freq.)	1.0	+	+	+	+	0.0	0.0	+	+	+	+	+	0.1
≥ 20 Feet (% freq.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	+	0.0	0.0	0.0	+
VISIBILITY (% FREQ.)													
Visibility <½ N. mile	2.0	2.1	1.9	2.6	3.0	2.7	1.0	0.7	0.8	1.2	1.5	1.9	1.8
Visibility <1 N. mile	3.8	3.9	3.3	3.7	4.1	3.6	1.6	1.4	1.5	2.3	2.4	3.2	2.9
Visibility <2 N. miles	6.7	6.8	5.9	5.9	5.9	5.5	3.1	3.3	3.6	4.2	4.5	6.0	5.6
Visibility <5 N. miles	17.3	18.0	16.1	15.2	14.9	17.7	14.5	16.9	15.5	14.4	14.8	17.4	16.1
Visibility <10 N. miles	48.3	49.2	46.4	49.7	48.8	56.8	55.4	57.1	50.4	44.1	45.3	47.5	50.0

Table II-12. Environmental Data Summary: Delaware Bay Area. (Adapted from Brower et al., 1972)

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ENVIRONMENTAL DATA SUMMARY (PART 2)

AREA: Delaware Bay

ENVIRONMENTAL FACTORS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
FOG													
Occurrence of fog (% freq.)	7.4	11.2	11.1	12.4	13.0	13.1	9.7	10.3	10.8	10.3	9.2	10.6	11.1
Mean number of hours operation of fog signals *	57	69	53	35	32	25	17	18	16	22	31	53	428
Maximum number of hours operation of fog signals for any year (annual only)*													840
WEATHER & CLOUDS (% FREQ.)													
Precipitation	11.3	11.1	11.0	9.1	7.3	5.6	4.8	5.3	6.3	6.4	8.5	10.0	8.1
Freezing precipitation	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Frozen precipitation	3.4	2.8	1.9	0.3	0.0	+	0.0	0.0	0.0	0.0	0.4	2.0	0.9
Thunder & lightning	0.2	0.1	0.2	0.5	1.2	1.3	1.8	1.6	0.7	0.2	0.3	0.1	0.7
Sky ≤2/8	34.4	35.2	39.2	36.8	36.2	37.9	37.1	38.0	43.2	46.1	38.5	34.5	38.2
Sky overcast (8/8)	38.7	37.6	34.1	33.4	30.8	25.1	23.2	23.8	25.1	25.3	30.1	35.3	30.1
Sky obscured	5.1	6.6	8.2	9.6	12.4	11.4	4.7	3.1	2.5	2.2	2.1	2.7	6.0
Low cloud overcast	26.0	23.9	19.7	17.5	16.1	12.5	10.5	11.9	13.3	13.7	17.3	21.3	17.0
Mean cloud cover (eighths)	4.9	5.0	4.8	4.8	4.8	4.5	4.6	4.5	4.2	3.9	4.7	4.9	4.6
AIR TEMPERATURE (°F)													
Minimum	-8	-7	7	12	25	37	46	40	32	23	11	0	-8
01% ≤	16	17	25	30	46	55	65	63	53	41	30	19	39
Mean	36.0	36.4	51.4	51.6	61.1	70.0	75.5	74.2	68.2	58.3	48.2	38.2	56.1
99% ≤	53	54	73	75	78	87	90	88	87	72	61	53	73
Maximum	78	76	87	89	99	106	104	101	100	91	85	75	106
≤ 32 °F (% freq.)	60.5	68.9	30.6	8.4	+	0.0	0.0	0.0	0.1	0.2	21.9	57.0	20.6
≥ 85 °F (% freq.)	0.0	0.0	0.2	0.3	0.7	19.8	28.0	20.3	10.0	0.3	+	0.0	6.6

* Mean of Miah Maull, Ship John and Delaware Bay Shoals fog signals

+ = less than 0.05%

Table II- 12. Continued.

AREA: Delaware Bay

ENVIRONMENTAL FACTORS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
RELATIVE HUMIDITY (%)													
Mean	72	71	71	71	73	76	77	77	77	76	74	73	74
SEA TEMPERATURE (°F)													
Minimum	28	28	27	33	40	41	54	57	56	46	38	28	27
01% ≤	28	29	33	39	42	53	63	65	58	51	44	34	45
Mean	41.2	39.8	42.5	48.6	56.7	65.8	72.0	73.4	71.0	62.9	54.2	45.5	56.1
99% ≤	57	57	60	70	72	78	82	82	80	74	65	58	70
Maximum	80	78	76	80	84	88	90	88	90	84	82	80	90
SALINITY (‰)													
Minimum	20.6	21.6	21.6	20.6	20.8	20.0	25.5	22.2	25.4	23.0	22.6	22.4	20.0
Mean	29.7	29.8	29.5	29.2	29.6	30.0	30.8	30.8	30.7	30.7	30.5	30.0	30.1
Maximum	34.5	34.1	33.6	34.2	34.6	35.0	34.6	34.1	34.1	34.0	34.1	33.6	35.0
DENSITY (ρ)													
Mean (σ_t)*	22.0	22.1	21.9	21.7	22.1	22.4	22.9	22.8	22.7	22.8	22.7	22.3	22.4
SEA-LEVEL PRESSURE (mb)													
Minimum	977	972	971	981	991	992	977	976	985	993	979	979	971
01% ≤	993	988	992	994	1000	1001	1002	1002	1001	998	994	995	997
Mean	1019	1018	1016	1015	1016	1015	1016	1016	1019	1018	1018	1019	1017
99% ≤	1042	1041	1038	1035	1034	1032	1029	1030	1038	1034	1039	1039	1036
Maximum	1045	1044	1042	1040	1037	1038	1031	1041	1043	1040	1040	1043	1045

* $\sigma_t = (\rho - 1) \times 10^3$; ρ = gm cm^{-3}

Table II-12. Continued.

dendritic tributary estuaries is a series of drowned river valleys. It is the largest estuarine system in North America, extending 165 nautical miles from the Virginia Capes to the mouth of the Susquehanna River. The bay proper has a surface area of $6.5 \times 10^9 m^2$, with a mean low water volume of $50 \times 10^9 m^3$. The bay plus its tributary estuaries has a surface area of $11.5 \times 10^9 m^3$ (3348 square nautical miles) and a mean low water volume of $74 \times 10^9 m^3$ (11.6 cubic miles). The average depth of the bay is 28 feet (Cronin, 1971). The main channel deepens from north to south except in the lower 60-off miles where the main channel becomes shallower before it deepens into the main ocean channel. The mean annual streamflow is about 75,000 cubic ft/sec (Bue, 1970), with the Susquehanna contributing 49 percent, and the Potomac 18 percent of the fresh water total. From the Potomac northward, the bay is a relatively simple estuarine system with one major fresh water source at its head. The lower 65 nautical miles of the bay is a composite estuary with multiple fresh water inputs along its western shore: James River, 16 percent; Rappahannock, 4 percent; York, 2 percent; other small streams, 4 percent, with only 7 percent of the total fresh water from streams along the eastern shore. The total annual fresh water inflow into the Chesapeake Bay system is slightly greater than its total volume (Pritchard, 1952).

Semi-diurnal reversing tidal currents of 0.5 to 3 knots encountered throughout the bay (Haight, Finnegan, and Anderson, 1930; Anonymous, 1968)

are the most obvious water movements. However, they are primarily responsible for supplying the energy to produce the vertical and horizontal mixing of the two-layer system described below.

The salinity increases from zero at the head of the estuary to about 32°/oo at the Virginia Capes. The main feature of the horizontal salinity distribution is the obliqueness of the isohalines, i.e., higher salinity on the east side and lower salinity on the west side. In the lower bay this could be related to the greater inflow from the rivers on the western side. But this oblique pattern, although less pronounced, is also present above the mouth of the Potomac and in tributary estuaries where the major fresh water input comes from a stream at the head of the estuary. This cross-stream salinity gradient appears to be due to geostrophic forces rather than to geography.

The vertical salinity profile has the general shape of an inverse tangent curve. The estuary may be considered as having two layers, i.e., a moderately stratified estuary. There is a net horizontal flow down the estuary in the upper layer and a net horizontal flow up the estuary in the lower layer. The boundary between the two layers has a slight lateral slope, with the right side (looking downstream) deeper than the left. The upper layer has a lower salinity than the lower layer. The volume of flow in the upper layer exceeds the volume of flow in the lower layer by an amount equal to the inflow of fresh water from the rivers.

The annual range in temperature in the open bay is often from about 0°C to approximately 29°C following the seasonal annual cycle. However, there are spatial variations in Chesapeake Bay somewhat larger than found in other bays. There may be a range in surface temperature along the axis of the bay as great at 7°C in August, with local gradients exceeding 1°C/km. Temperatures on the Virginia side of the bay are on the average about 0.5°C warmer than on the Maryland side (Schubel, 1972).

Seitz (1971) reports the results of a series of monthly temperature and salinity profiles along the main axis of the bay. He finds two main factors which determine the major non-tidal circulation: (a) Fresh water enters the surface layer from the rivers and travels toward the sea. This creates a fresher surface layer and a saltier bottom layer everywhere in the estuary. (b) The surface layers of the bay, river, and ocean are continually being warmed and cooled creating several possible vertical temperature structures throughout the year. Seitz postulates four such temperature-salinity structures, three of which were observed. From March to August warm-fresh water overlies colder-saltier water. From September to December cold-fresh water overlies warm-saltier water. During January and February cold-fresh water overlies cold-saltier water. The fourth possibility of warm-fresh water overlying warm-saltier water may be a temporary condition near the end of August or early September.

Pritchard (1952) has pointed out that salinity governs the dynamic structure of the bay, but Seitz (1971) has pointed out that the temperature significantly modifies the density stratification in the middle part of the bay. In summer months the temperature gradient accounts for 18 percent of the total vertical density gradient, while in autumn the inverse temperature gradient tends to reduce the vertical density stratification resulting from the salinity gradient. The resultant axial non-tidal circulation for the periods March-August and September-December as diagrammed by Seitz are presented as Fig. II-29.

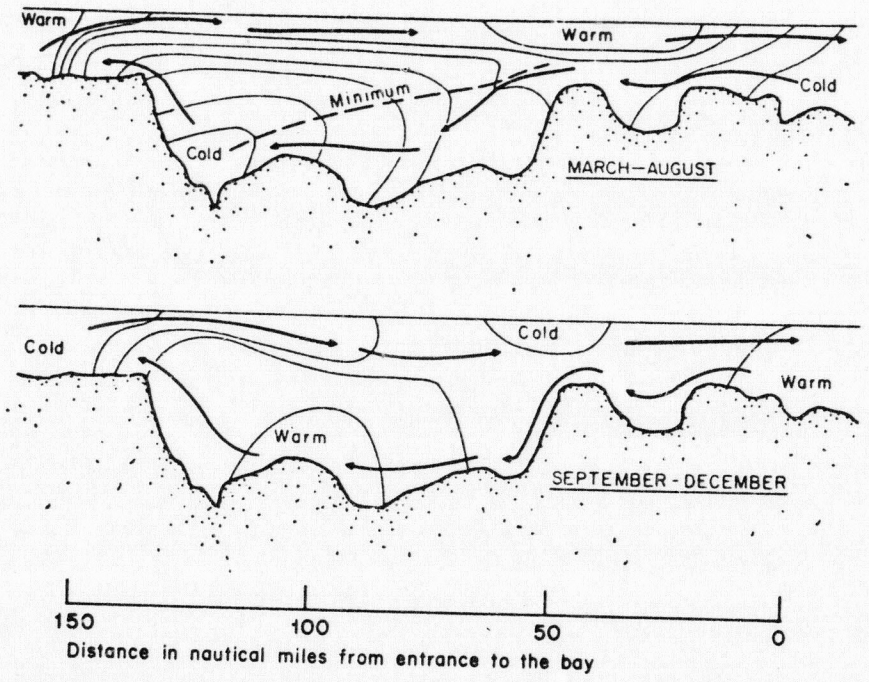


Figure II-29.

Schematic of circulation in Chesapeake Bay during surface warming and surface cooling (after Seitz, 1971).

8. Oceanographic Data Needs

Section I.D.2. describes the environmental studies program of BLM. Further work, however, is needed in a number of subject areas. The use of properly designed current meters at multiple depths over an entire year or more in conjunction with passive drift studies (bottles, cards, or buoys) and fixed meteorological buoys across the shelf are needed to develop better understanding of water circulation across the shelf and at the shelf/slope boundary. Standardized measurements of temperature, salinity, and dissolved oxygen should be carried out at the same time through the water column. Studies in NOAA's MESA project area and current or future BLM environmental studies, and USGS, EPA, and university research may eventually accomplish these goals over the next decade or so. Inability to effectively deal with an open boundary condition will possibly continue to restrict the development of accurate models. Knowledge of internal water dynamics (mid-depth phenomena) is presently at an elementary level and is also decades away from comprehensive understanding.

D. Water Quality

1. Offshore and Near Shore

a. Continental Shelf Waters (South of Long Island)

A thorough study of the Continental Shelf from Cape Hatteras to Buzzards Bay was conducted in September 1969 on board the R/V Atlantic II and is reported by Corwin (1970). Figure II-30 shows dissolved oxygen values at 15 meter depths and indicates that within approximately 30 miles (48 km) of the coast there is substantial consumption of oxygen by both natural and man-induced processes (Kester and Courant, 1973). Phosphate and nitrate data were collected by Ketchum et al. (1958) as shown in Figure II-31. These graphs illustrate the seasonal stratification and the depletion and replenishment that occur. Table II-13 includes other oxygen, phosphate, and nitrate data that indicate stratification.

Table II-13. Variation of Biologically Active Components in Continental Shelf Waters During August 1969 (Data selected from Corwin, 1970)

Parameter	Upper 10 m	Lower 10 m
Oxygen (mℓ/ℓ)	5.0	2.0
Phosphate (µg at/ℓ)	0.4	1.2
Nitrate (µg at/ℓ)	0.1	2.0

(Adapted from Kester and Courant, 1973)

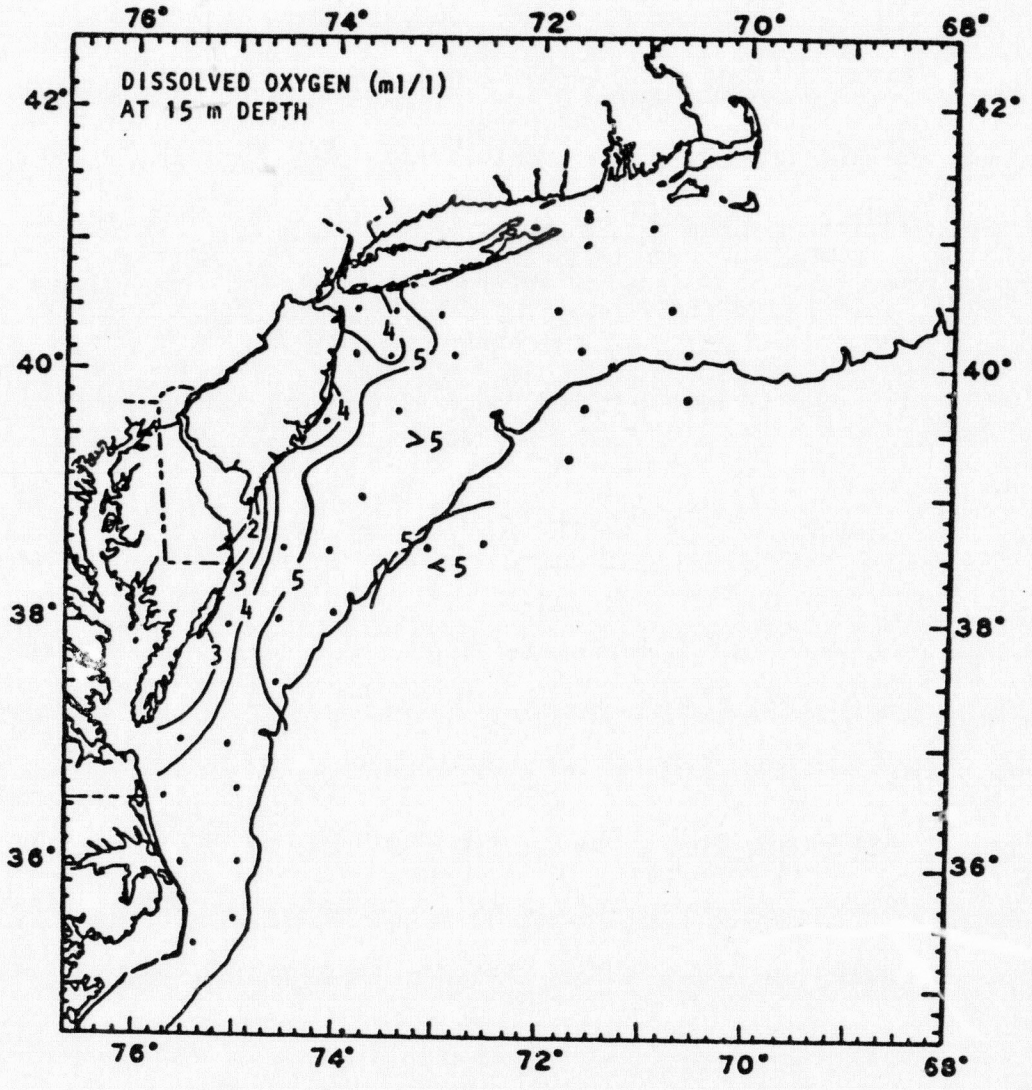


Figure II-30. Distribution of Dissolved Oxygen at a Depth of 15 m (Based on Data of Corwin, 1970)

(Adapted from Kester and Courant, 1973)

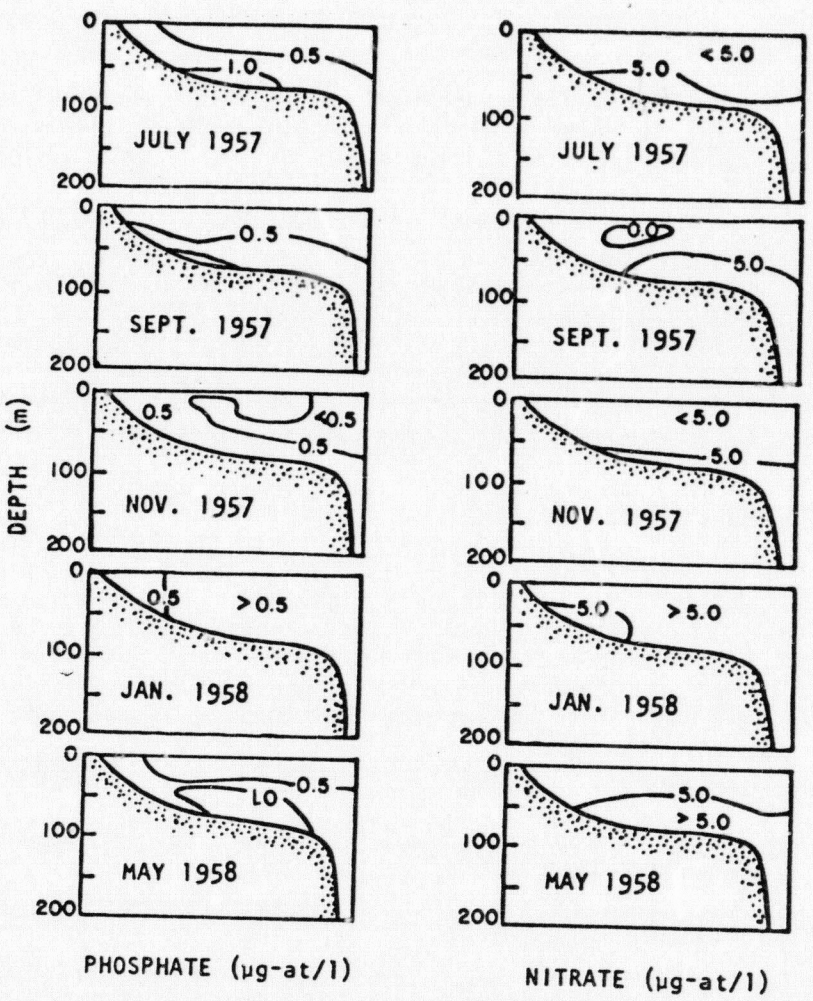


Figure II-31. Seasonal Distribution of Phosphate and Nitrate Across the Continental Shelf South of Long Island
(Based on Data of Ketchum, Vaccaro, and Corwin, 1958)

Studies conducted by Mead et al. (1975) in September 1969 and Manheim et al. (1970) for May and June 1965 show that concentrations of suspended sediment are generally less than 1 mg/ℓ just offshore and decrease seaward to 0.1 mg/ℓ near the shelf edge. Mead et al. (1975) have suggested that higher levels of suspended sediments are found in bottom waters and that much of this is resuspended bottom sediment. Other primary sources of solids in the water column include river runoff, organic production, and ocean dumping (Figure II-32).

The apparent lack of deposition on the shelf tends to indicate that material which enters the OCS is either transported back into the coastal region or accumulates in the deep sea.

Measurements of light scattering in Continental Shelf waters has not been very successful as a result of the very low concentrations of suspended sediment.

b. Great South Bay

The problems of Great South Bay are representative of those affecting most of the bays on the southern shore of Long Island. Increased nutrient additions resulting from increased development along the northern shore of the Great South Bay have caused an increase in algal populations in some areas. A recent study by Hair and Buckner (1973) measured concentrations of nitrogen and phosphorous and found them highest in the western and northern sections of the Bay. Dissolved oxygen

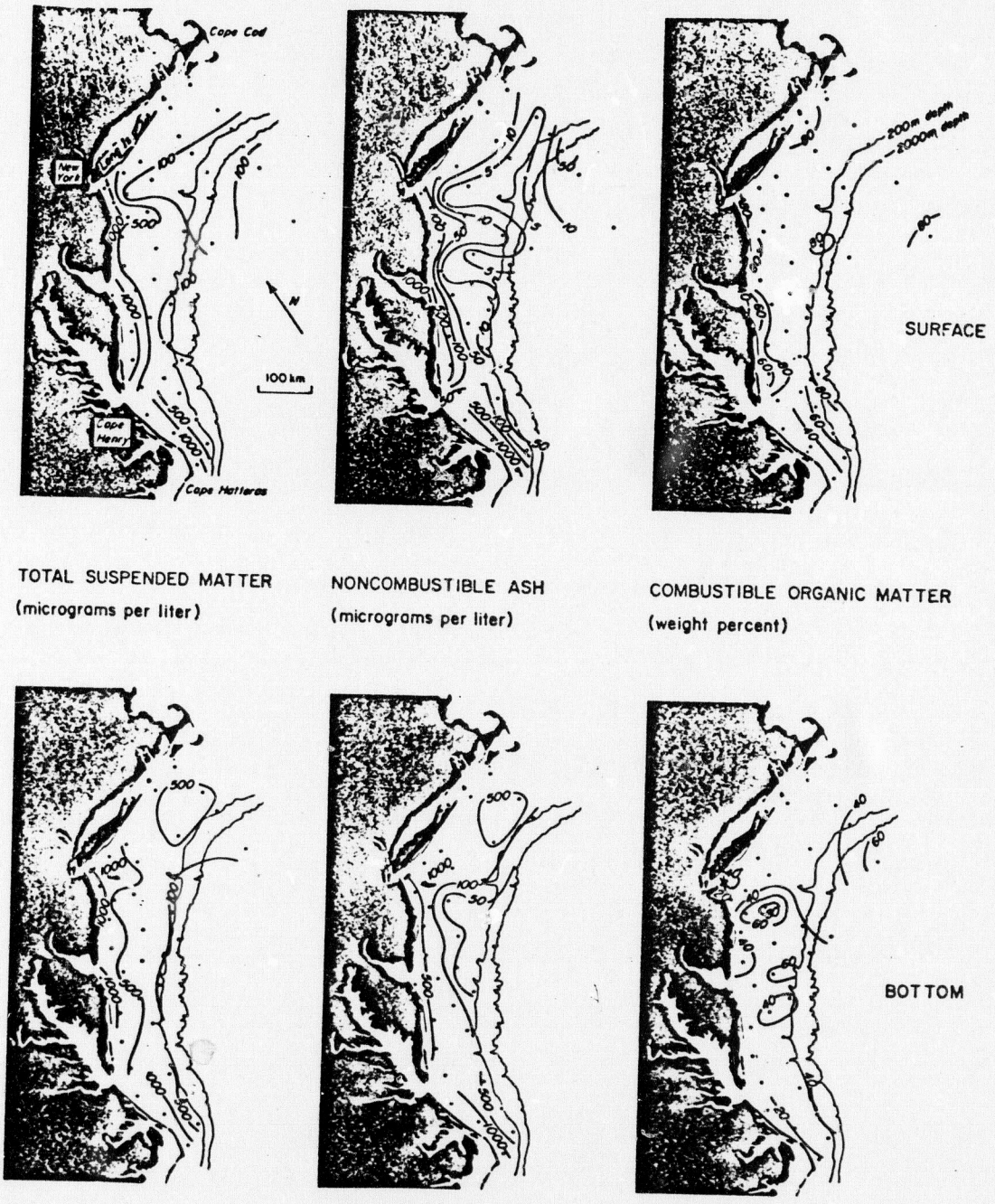


Figure II-32. Maps Showing Distribution and Composition of Suspended Matter in Near-surface and Near-bottom Waters of the Mid-Atlantic Bight, September 1969 ("Surface" samples from 5-6 m depth; "Bottom" samples taken within 2-5 m of bottom,
(From Meade et al., 1975)

was also measured and found to be near or above 100 percent saturation where sampled.

Some shellfish areas have been closed in recent years due to high coliform counts, median MPN (most probable number) of 58 to 600 per 100 ml, and an increase in the population of the "small form" of bloom algae. The increase in this particular strain led to a decrease in the oyster population by stimulating the growth of serpulid worms (TRIGOM, 1974). However, many shellfish areas are still open to commercial and recreational fishing. In fact, economically important commercial fisheries are supported by abundant populations of bay scallops, soft shelled clams, and hard clams. It should also be emphasized that although natural oyster reproduction has declined in recent years, seed oysters are "planted" and grown on privately-leased bottom lands for commercial harvest. (Taken from written comments submitted by the Department of Commerce for draft EIS for Sale #40).

c. New York Bight

The dissolved oxygen in the Bight area varies with proximity to the dump sites as shown in Figure II-33, as well as seasonally in Figure II-34. The Sandy Hook Laboratory Study (1972) showed values of less than 2.0 ppm to 15.2 ppm with the lowest values found near the bottom during late summer and the highest values found during late winter and early spring.

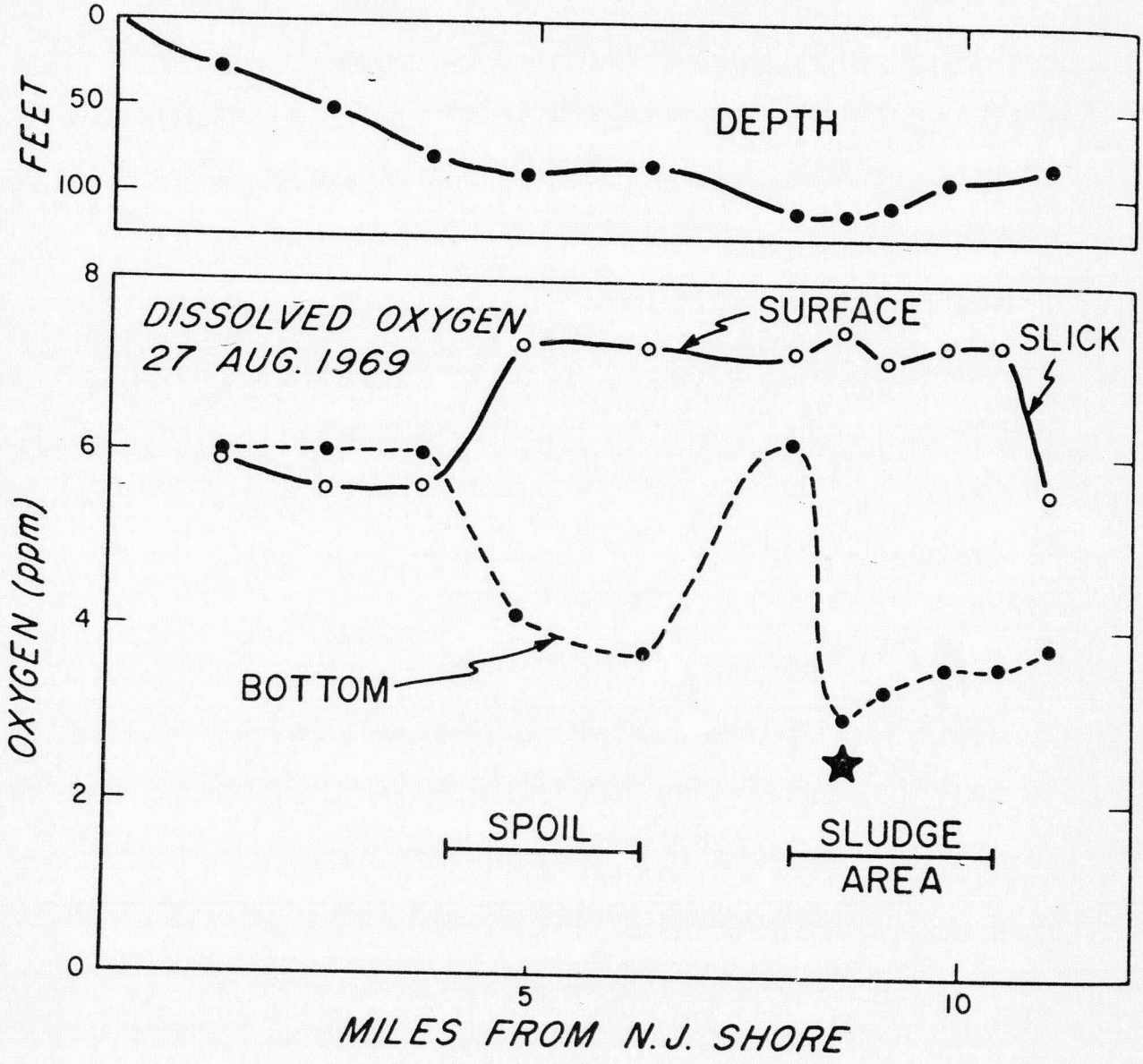


Figure II- 33. Dissolved Oxygen Content of Surface Water and Water Three Feet Off Bottom in the New York Bight Area (Ketchum, 1970)

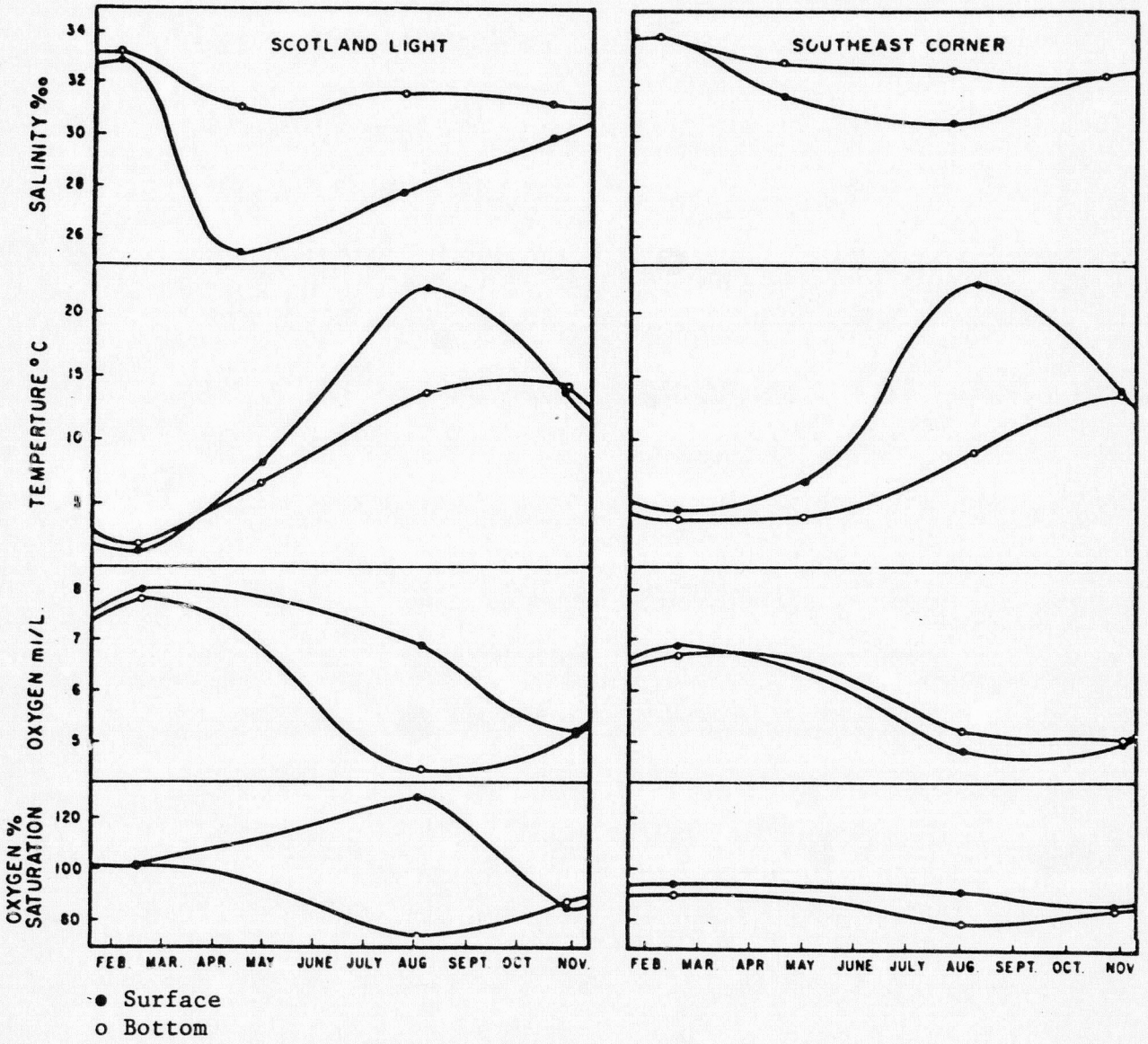


Figure II-34. Seasonal Variations of Certain Physical Properties at Two Stations in the New York Bight (Ketchum et al., 1951)

(Adapted from TRIGOM, 1974)

Nutrient levels in the Bight area also vary with season and proximity to the dump sites. The four billion kiloliters of waste material dumped into the New York Bight area every day include 90 metric tons of nitrogen and 26 metric tons of phosphorus (Ryther and Dunstan, 1971). The phosphorus, most of which comes from domestic detergents, is in excess of that needed by the phytoplankton and the remainder is carried along the New Jersey coast by the prevailing currents. Nitrogen, however, seems to be utilized very quickly and the only really high values are found in New York Harbor and Raritan Bay (Figure II-35). Surface nitrate measurements were also made on the MESA cruises during periods of highly stratified and well-mixed conditions (Figure II-36).

Transparency of the New York Bight area water is shown in Figure II-37. Pararas-Carayannis (1973) summarized earlier studies of the New York Bight and concluded that the turbidity in the Bight is due to both fine grained suspended matter (clay, silt, and organic matter) and the ferric hydroxide flux resulting from the disposal of acid wastes. The greatest source of settleable solids in the Bight is from ocean dumping (Gross, 1970). The fine-

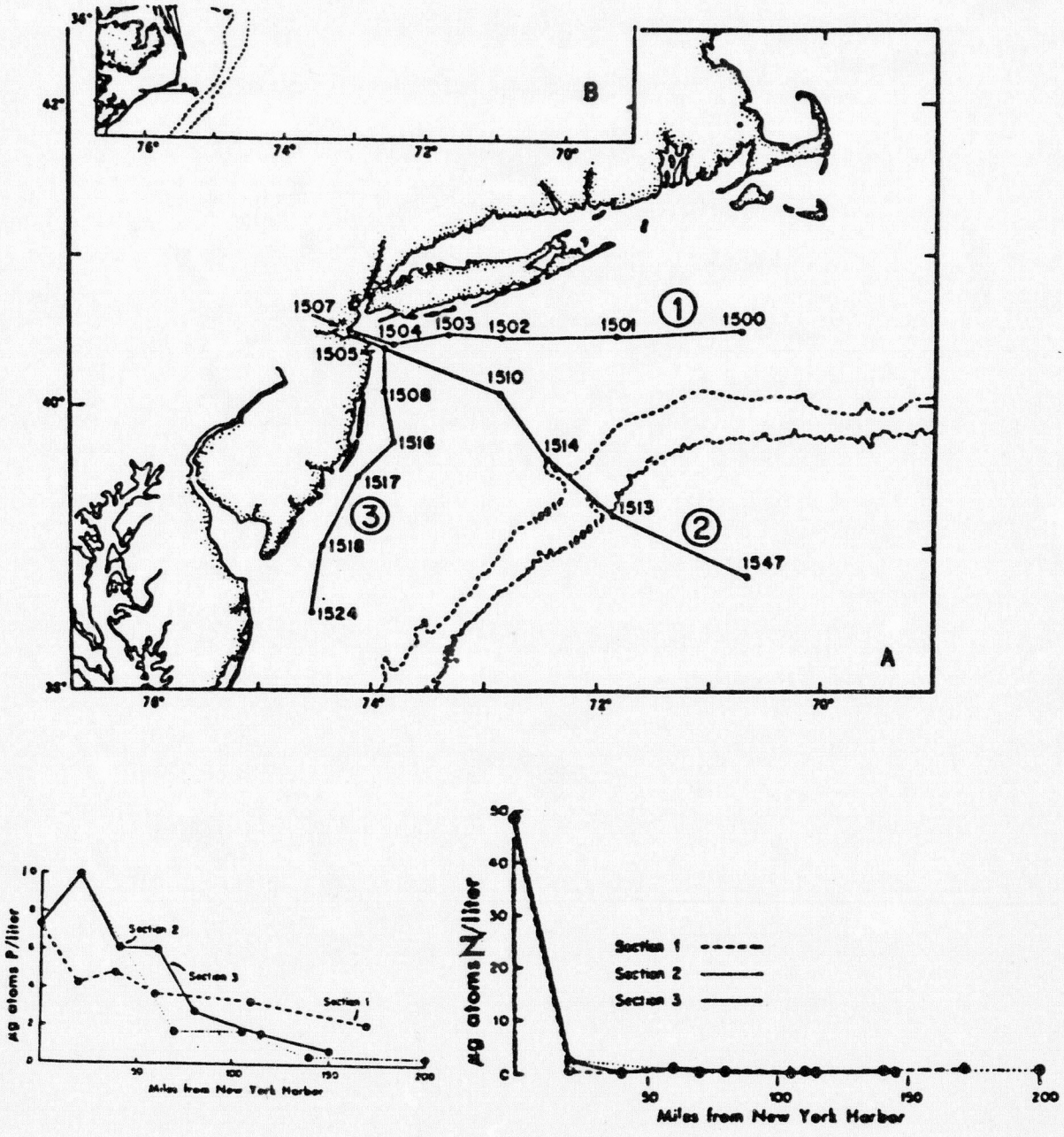
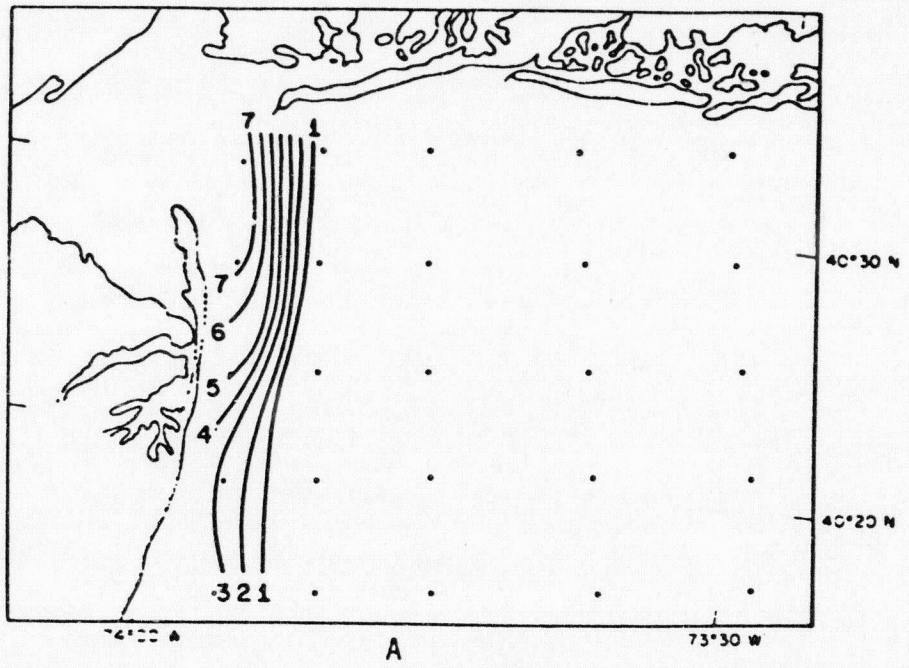


Figure II-35. Distribution of Phosphate and Inorganic Nitrogen (Ryther and Dunstan, 1971)

(Adapted from TRIGOM, 1974)



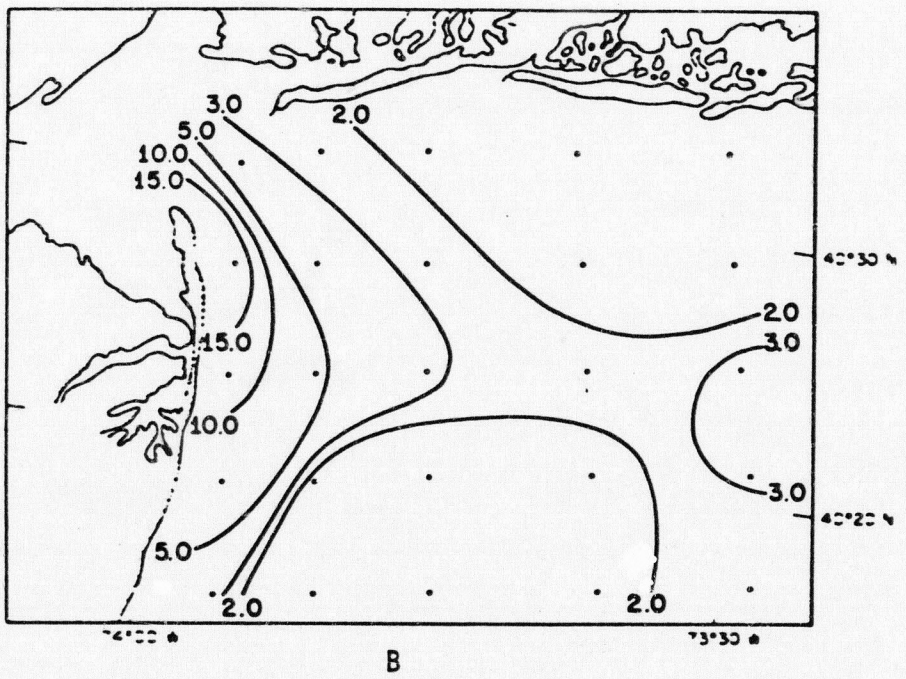
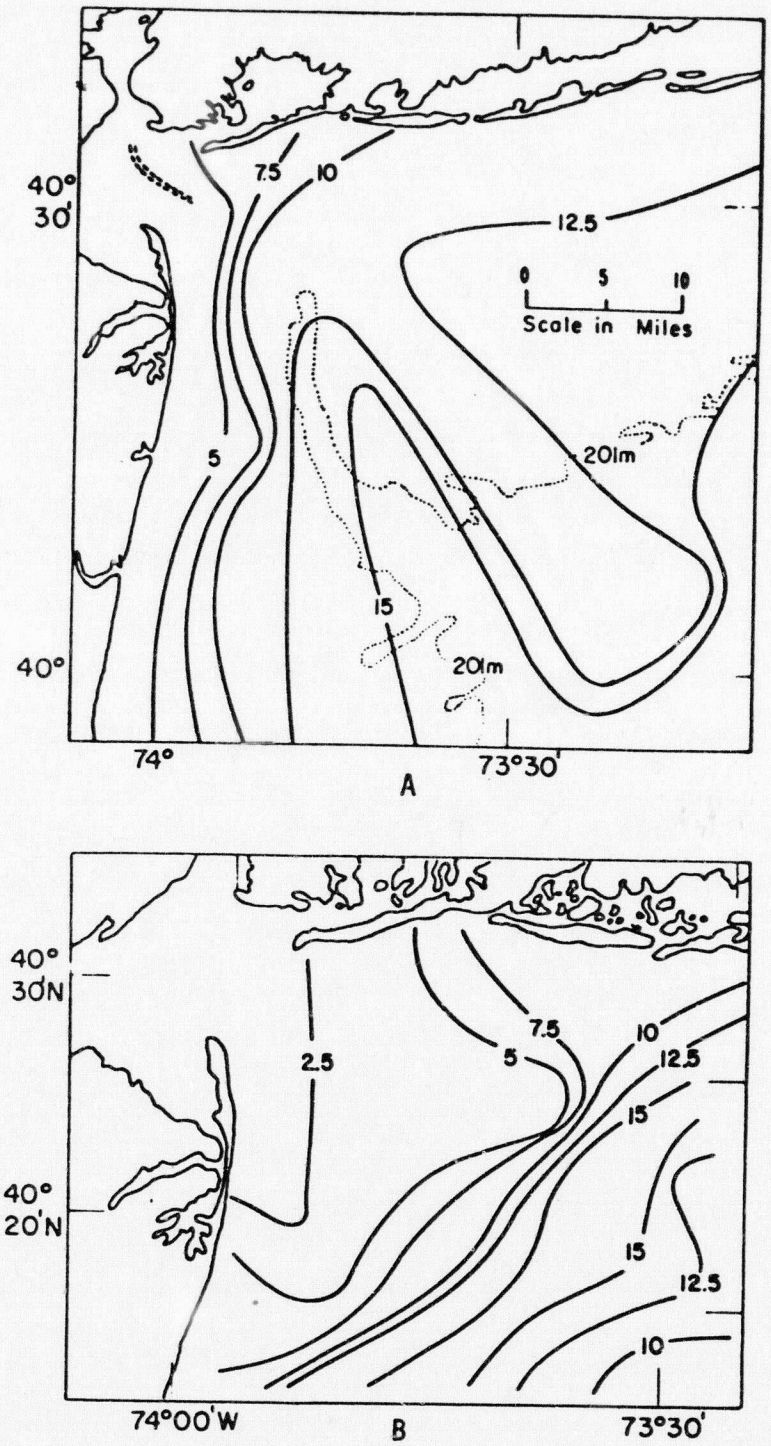


Figure II- 36. A - Surface Nitrate, 16-20 September 1973
B - Surface Nitrate 25-29 November 1973
(µg - atoms per liter)

(From MESA, 1975)



A - August 1949 (from the NAS Study). B - Secchi disc depths in the New York Bight Apex obtained during MESA cruise, WCC-10, August 1974. Contours show depths in feet.

Figure II- 37. Transparency of Waters of the New York Bight (From MESA, 1975)

grained dredge wastes, equal to 76 percent of the total wastes dumped (Gross, 1972), exceed the input of any river on the United States Atlantic Coast (Holeman, 1968).

A number of other chemical elements have been measured in the New York Bight area (Table II-14). Iron, for example, is contained in acid wastes (8.5 percent sulfuric acid and 10 percent ferrous sulfate in solution) that are dumped in the Bight. The acid is quickly neutralized by seawater and the ferrous iron is oxidized to ferric iron and precipitates as an iron hydroxide. The amount of iron dumped in the area has increased from 60 tons per day in 1948 to 229 tons per day in 1969 and 1970 with subsequent maximum dissolved iron concentrations of 1 µg at/ℓ in 1950 to 8.9 µg at/ℓ in 1969 and 1970 (Pararas-Carayannis, 1973). Sandy Hook Laboratory (1972) found the total concentration of iron for surface, mid-depth, and bottom water to average 0.46 to 3.42 µg at Fe/ℓ with the highest values in the bottom water. The iron-rich deposits appear to be spread along the bottom by bottom currents which are associated with an increase in bottom turbidity (TRIGOM, 1974).

Table II-14. Ranges of Chemical Data Measurements Near the New York Dumping Grounds

Chemical Variable	Range
Total iron	0.0 to 37.3 µg at/ℓ*
Chlorophyll-a	0.38 to 33.3 µg at/ℓ
Nitrate	0.0 to 2.28 µg at/ℓ
Orthophosphate	0.02 to 5.64 µg at/ℓ
Organic phosphate	0.04 to 2.28 µg at/ℓ
Metaphosphate	0.01 to 2.35 µg at/ℓ
Total phosphate	0.84 to 7.48 µg at/ℓ
Dissolved oxygen	2.0 to 15.2 ppm**
pH	7.10 to 8.40
Lead in sediment	0.55 to 249 ppm
Copper in sediment	0.013 to 338 ppm
Chromium in sediment	0.25 to 197 ppm

* Microgram-atom per liter
**Parts per million

(From Sandy Hook Laboratory, 1972)

d. Raritan Bay

Raritan Bay is a seriously polluted estuary surrounded by an intensely developed area. Corwin (1970) reported very low levels of dissolved oxygen at the entrance (1.8 mℓ/ℓ at 8 m) and Jeffries (1962) found values there of up to 100 times greater for nitrate and five times greater for phosphate than in the Continental Shelf waters. Most of this load is due to discharge of municipal and industrial effluents and produces eutrophic conditions in the summer. Coliform bacteria counts are high and have forced the closing of some public beaches (Jenny and Goodman, 1975).

e. Delaware Bay

Dissolved oxygen data from the University of Delaware studies (Kupferman, 1971) show a high degree of vertical mixing throughout the Bay which is independent of the seasons. It also indicates lower values at the head of the Bay due to waste loads discharged by the Delaware River. Much of the waste matter generated in the area is produced by existing heavy petroleum refining and petrochemical industries and as a result carries a relatively high amount of oil and other organic pollutants (Figures II-38 and II-39).[1]

Oostdam and Jordan (1973) and Jordan (1968) have demonstrated that net landward transport of suspended sediment takes place over the entire tidal cycle along the shores of Delaware Bay and suggest that net seaward transport occurs at the center of the Bay mouth.

f. Chesapeake Bay

According to Kester and Courant (1973), oxygen typically decreases from the head of the Bay entrance, and in the lower Bay there is some cross-channel skewness which follows the temperature and salinity and which is related to the greater inflow of ocean water along the eastern side. The vertical and seasonal variations in oxygen are of greater magnitude than the horizontal gradients. The vertical distribution is represented by a section along the axis of the Bay in the winter and in the summer (Figure II-40 and II-41). During the winter the waters are aerated at all depths, but during the summer water

[1] EPA point source, effluent limitations (Section III.D.) may reduce these loadings in the future.

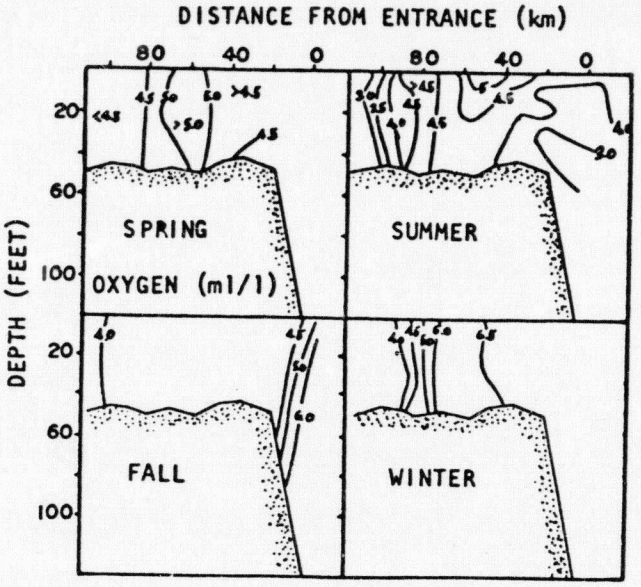


Figure II-38. Vertical Profiles and Seasonal Variation of Oxygen along the Main Axis of Delaware Bay
(From Kester and Courant, 1973)

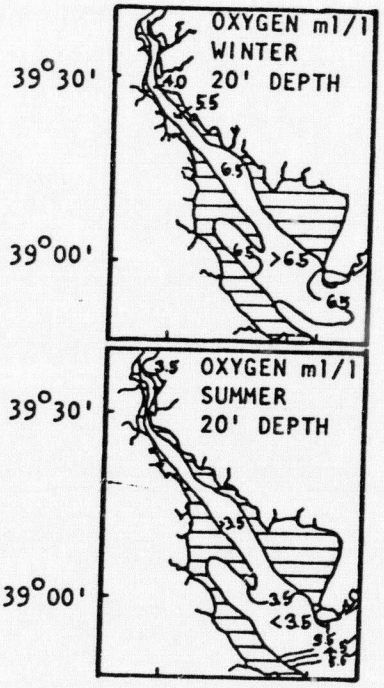


Figure II-39. Spatial Variation of Oxygen in Summer and Winter
(From Kester and Courant, 1973)

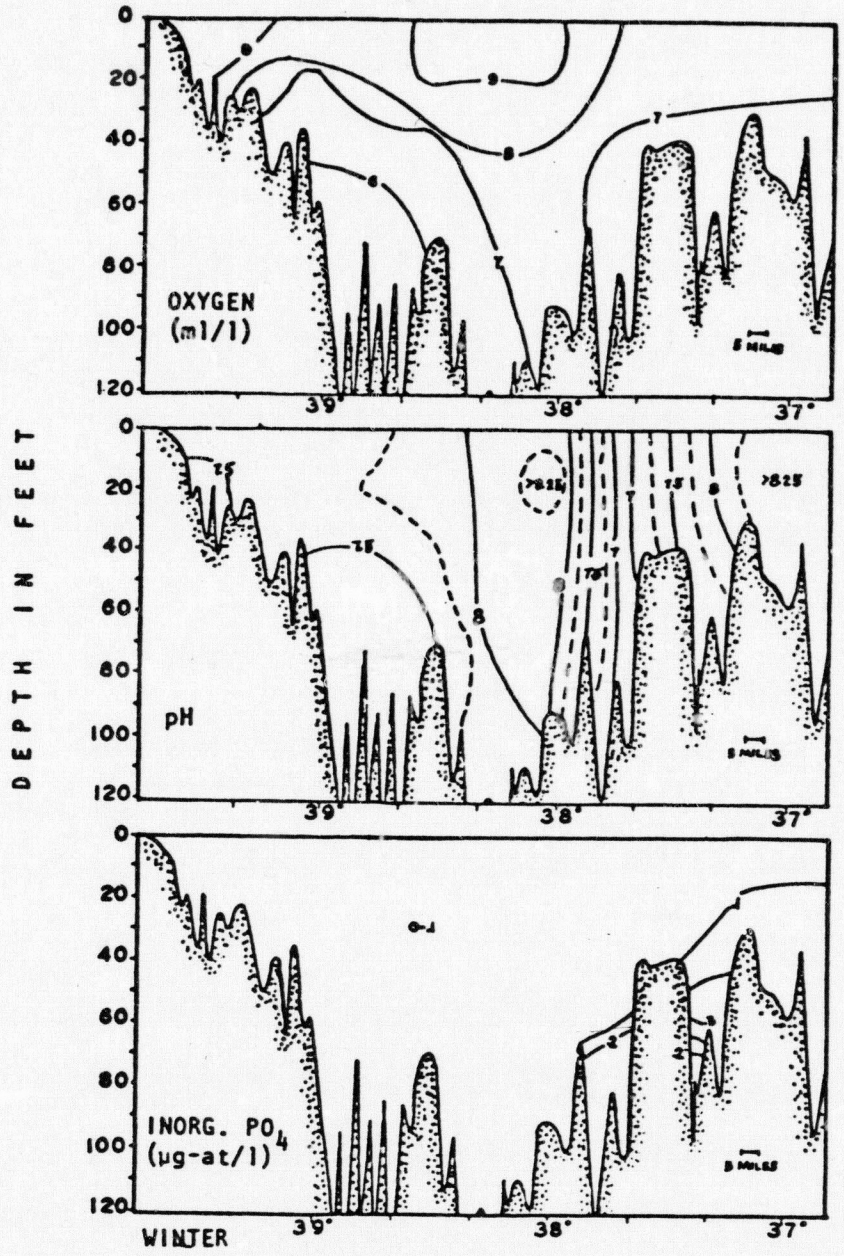


Figure II-40. Vertical section of oxygen, P^H, and phosphate along the axis of Chesapeake Bay in the winter. Adapted from Kester and Courant, 1973.

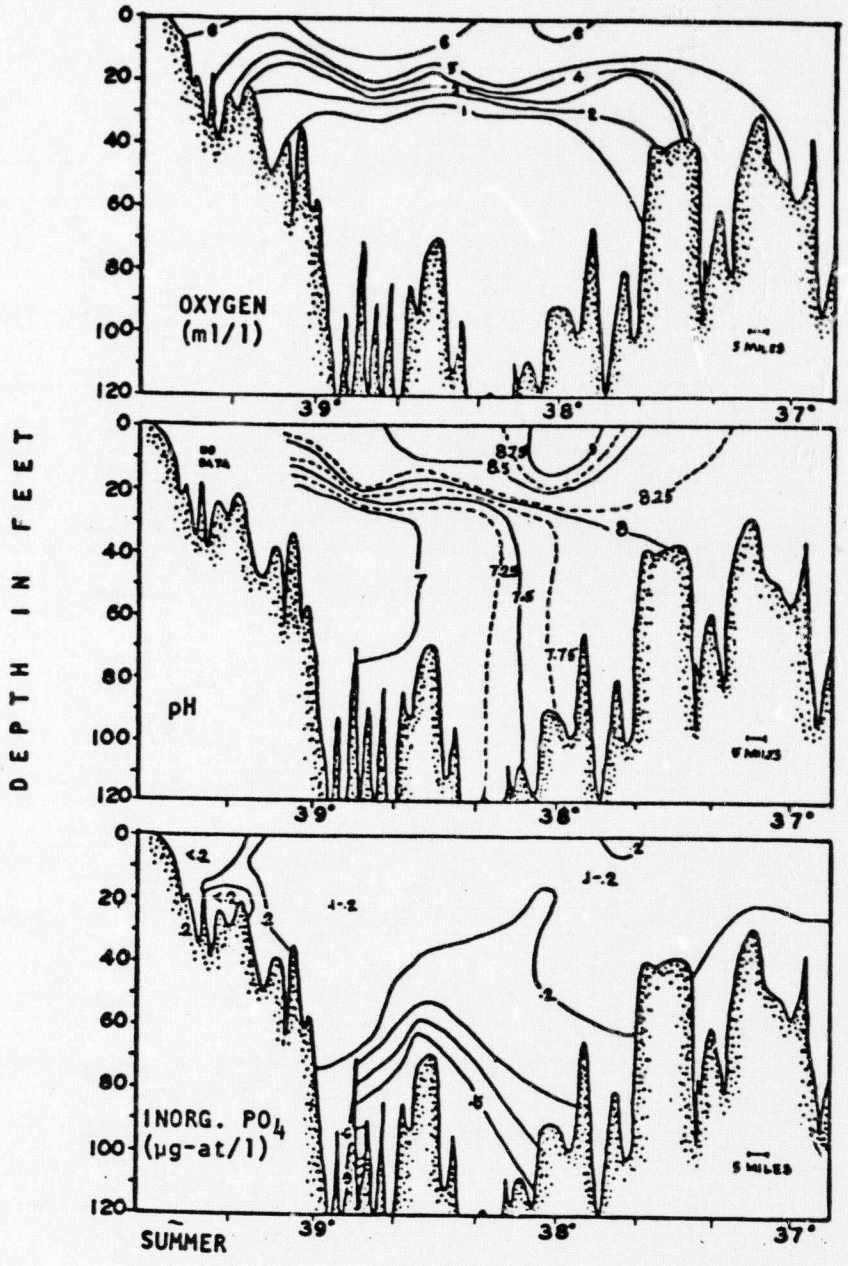


Figure II- 41. Vertical section of oyxgen, P^H, and phosphate along the axis of Chesapeake Bay in the summer. dapted from Kester and Courant, 1973.

below 30 feet contains less than 1 ml/l of oxygen. Anoxic conditions (undetectable oxygen concentrations and the presence of sulfide) have not been observed in the main portion of the Bay, but some of the tributaries (the Severn, the Potomac, and Eastern Bay) do contain anoxic regions during the summer (Schubel, 1972).

Many of the other chemical components may be related to, and understood in terms of, the dissolved oxygen. Figures II-40 and II-41 show the p^H and inorganic phosphate for comparison with oxygen. The absence of vertical p^H gradients and the homogeniety of phosphate in the winter provide further evidence of extensive vertical mixing and a relative lack of biological activity during this period. In the summer the consumption of oxygen in the deep regions is associated with reduced p^H and increased phosphate concentrations, as expected from the previously discussed chemical model.

The major vertical, latitudinal, and seasonal variations of bioligically active components in Chesapeake Bay are summarized in Figure II-42. The chlorophyll data provide an indication of the abundance of photosynthetic organisms which increase in summer and fall at the surface. The nitrogen compounds (nitrate, nitrite, and ammonia) show a general decrease from the head to the entrance of the Bay.

Suspended sediment in Chesapeake Bay has been studied extensively by Schubel (1969). The distribution of suspended sediment varies with tidal currents which produce resuspension of material off the bottom and with seasonal fluxes of major rivers such as the Susquehanna. During the spring

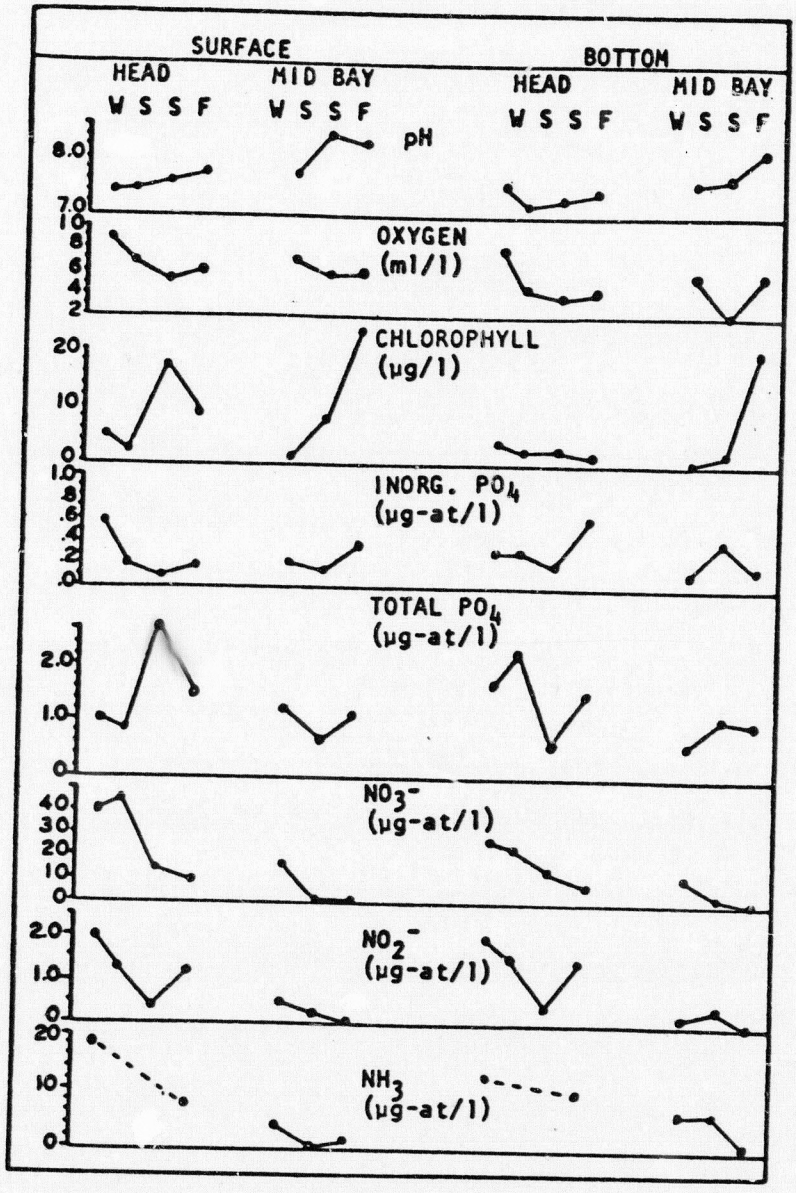


Figure II-42. Seasonal variations of chemicalparanmeters in surface and bottom waters at two locations in Chesapeake Bay. Adapted from Kester and Courant, 1973.

freshet the suspended material may range from 140 mg/1 at the head to 20 mg/1 at mid-Bay. At the transition between fresh and marine water, Schubel observed 70 mg/1 of suspended sediment above the pycnocline and a similar quantity near the bottom, but just beneath the pycnocline the suspended matter decreased to about 36 mg/1.

Schubel's (1972) report also contains values for manganese (100-450 µg/1), copper (2-8 µg/1), nickel (2-14 µg/1), and zinc (5-70 µg/1). The high levels of each trace metal is generally associated with a seasonal maximum in river flow into the Bay.

2. Onshore

For the Mid-Atlantic area in general, water quality degradation is the result of municipal and industrial organic waste loading and the inorganic sediment loads. Significant pollution problems occur downstream from large urban concentrations because of this. Without this proposal, the nonindustrial waste load is expected to double the 1960 level by the year 2020 and the industrial waste is expected to increase by tenfold (NAR, 1972). However, it is also anticipated that both types of waste loads after treatment will decrease or only rise slightly if the treatment implemented conforms

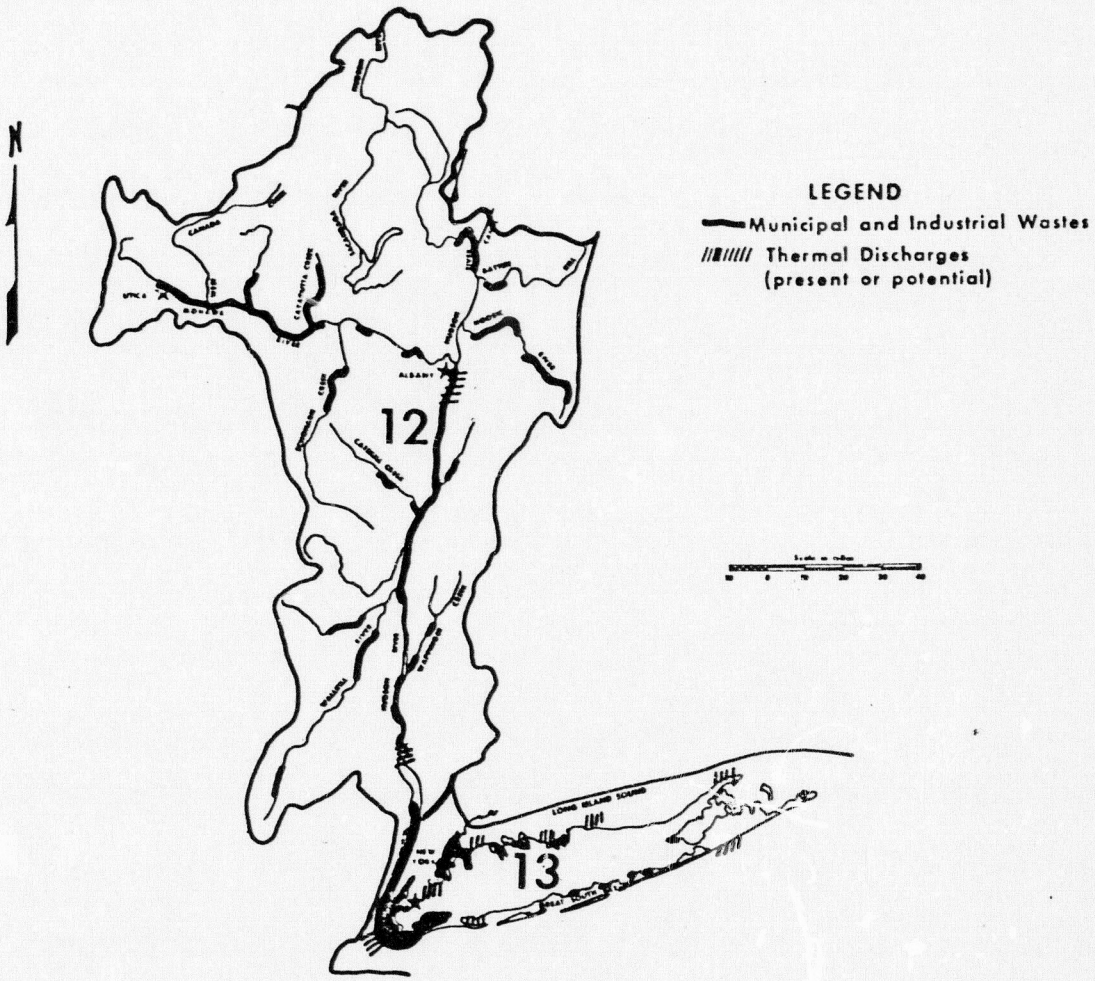
to the effluent and instream state and Federal regulations (NAR, 1972).

The following includes a brief description of the areas expected to be affected by development of the proposed leasing area in terms of their present waste loads and those predicted for the future with 'normal' growth. This information has been taken from the North Atlantic Regional Water Resources Study (NAR, 1972). It does not reflect the most recent data on the effectiveness of sewage treatment facilities or water supply, but it does provide region-wide information in these areas that can be used as a basis for predicting impacts.

a. New York

The area considered is shown in Figure II-43. The water systems carrying municipal and industrial wastes and subject to thermal discharges are indicated.

The New York area waters receive the largest quantities of both non-industrial and industrial wastes in the Mid-and North Atlantic area. Area 13 has a population density of 5300 persons/square mile and will continue to maintain this extremely high level so that those pollution problems related to population will persist. At present the waters in the area are used for municipal and industrial water supply, extensive boating and swimming, commercial fishing (although this has been somewhat curtailed in recent years because of environmental changes due to



AREAS 12 AND 13

Figure II- 43. Water Quality Problem Areas
(Adapted from NAR Water Resources Study, 1972)

pollution), commercial navigation (especially in and around New York Harbor), power generation, and irrigation.

All the major water systems in this area receive municipal, industrial, and agricultural wastes. The organic waste load from nonindustrial and industrial sources is the most significant cause of degradation while the inorganic waste load and the combined sewer overflows are second. Tables II-15 and II-16 show the present and predicted loads both before and after treatment through the year 2020 (without this proposal).

Continuation of the existing abatement and implementation plans will cause the 1980 nonindustrial waste load to be less than half the 1960 load while the waste loads of 2000 and 2020 will remain at the 1980 level. Also under the existing plans, the industrial waste load for 1980 will be approximately half the 1960 waste load but will increase with time and more than double by 2020.

Other problems include the remaining septic tank-cesspool systems although these are being updated and brought in line with state regulations. Thermal pollution from electrical generating plants and industrial cooling towers is a problem here. Recreational boating, common in and around Long Island, and the commercial navigation in the harbor areas create pollution problems from waste oil, oil spills, motor exhaust, litter, and sewage. Dredging of the navigation

Table II-15. Present and Future Organic Waste Loads--Planning Area No. 12

Year	Non Industrial Waste Load[1] P.E.[3] (000) Before Treatment	Non Industrial Waste Load[1] P.E.[3] (000) After Treatment[4]	Industrial Waste Load[2] P.E. (000) Before Treatment	Industrial Waste Load[2] P.E. (000) After Treatment[4]	Total Waste Load P.E (000) Before Treatment	Total Waste Load P.E (000) After Treatment
1960	1,980[5]	1,650	4,200	2,890	6,180	4,500
1980	2,320	350	7,700	1,150	10,000	1,500
2000	2,800	280	14,400	1,420	17,200	1,700
2020	3,390	340	28,000	2,840	31,800	3,200

[1]Includes waste loads from municipalities, institutions, and Federal installations.

[2]Includes the waste loads from the six major water-using two digit Standard Industrial Code groups.

[3]Population Equivalent - the amount of waste (BOD) equal to that produced each day by one person (0.17 lbs/person/day).

[4]This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000, and 2020 without the proposed action.

[5]Includes 766,000 persons not served by non-industrial waste collection systems.

(From NAR Water Resources Study, 1972)

Table II-16. Present and Future Organic Waste Loads--Planning Area No. 13

Year	Non Industrial Waste Load[1] P.E.[3] (000) Before Treatment	Non Industrial Waste Load[1] P.E.[3] (000) After Treatment[4]	Industrial Waste Load[2] P.E. (000) Before Treatment	Industrial Waste Load[2] P.E. (000) After Treatment[4]	Total Waste Load P.E. (000) Before Treatment	Total Waste Load P.E. (000) After Treatment
1960	10,600[5]	4,200	14,300	7,100	24,900	11,300
1980	12,900	1,940	28,500	4,270	41,000	6,210
2000	15,640	1,560	52,500	5,254	68,000	6,818
2020	18,800	1,880	99,400	9,940	118,000	11,814

[1]Includes waste loads from municipalities, institutions and Federal installations.

[2]Includes the waste loads from the six major water-using two digit Standard Industrial Code groups.

[3]Population Equivalent - the amount of waste (BOD) equal to that produced each day by one person (0.17 lbs/person/day).

[4]This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000, and 2020 without the proposed action.

[5]Includes 506,000 persons not served by non-industrial waste collection systems.

(From NAR Water Resources Study, 1972)

channels creates problems of turbidity and once-settled pollutants being resuspended. Rural and urban runoff carrying pesticides, fertilizers, oils, litter, and so on are also problems that are expected to grow as the area becomes more urbanized.

Most of the fresh water needed to supply public and industrial users in Areas 12 and 13 is obtained from surface sources (>70 percent) while the remainder is obtained from ground water aquifers. Diversion from Areas 12 and 15 (New Jersey) provides the bulk of water for the New York City metropolitan area while Nassau and Suffolk counties obtain fresh water from the aquifers described in Section II.A.4.c. Industry in the area uses brackish water and publicly or self-supplied fresh water.

In Area 12 (Hudson River drainage area) in 1972, 226 mgd were used for public supply and 315 mgd for industrial supply (280 mgd of self-supplied fresh water, 24 mgd of publicly supplied fresh water, and 11 mgd of brackish water). In Area 13, 1404 mgd were used for public supply and 276 mgd for industrial supply (13 mgd of self-supplied fresh water, 90 mgd of publicly supplied fresh water, and 173 mgd of brackish water). Needs in both of these categories are expected to increase in the future.

In Area 12, the average annual rainfall is 13,190 mgd of which 2261 mgd (17 percent) are available at present. In Area 13, these values are 1900 mgd and 623 mgd (33 percent) respectively. By providing

additional reservoir and water treatment plant capacity, increasing the number of intakes and pumping stations, and developing ground water supplies, Area 12 could supply 7838 mgd or 59 percent of its average annual runoff, and Area 13 could supply 1212 mgd or 64 percent of its runoff for future water uses.

It is anticipated that in the future in Area 12 limitations may be applied to the industrial use of surface water. This would result either in restricting withdrawal or in some form of cost sharing by industry and the public sector for facilities needed to maintain minimum flows in the area's rivers.

b. New Jersey, Delaware, and Pennsylvania

The area considered is shown in Figure II-44 and the water systems carrying municipal and industrial waste and subject to thermal discharges are indicated.

This area which includes Delaware and Raritan Bays, ranks first in the NAR-defined region[1] in the total manufacturing employment and second in population. It has an overall population density of 625 persons/square mile and is expected to increase and maintain a very high density even without this proposed action (1360 persons/square mile in 2020). At present the waters in the area are used for municipal and industrial water supply, extensive boating and swimming, sport fishing, commercial fishing (although this has been curtailed due to pollution in recent years), commercial navigation, some power generation, and irrigation.

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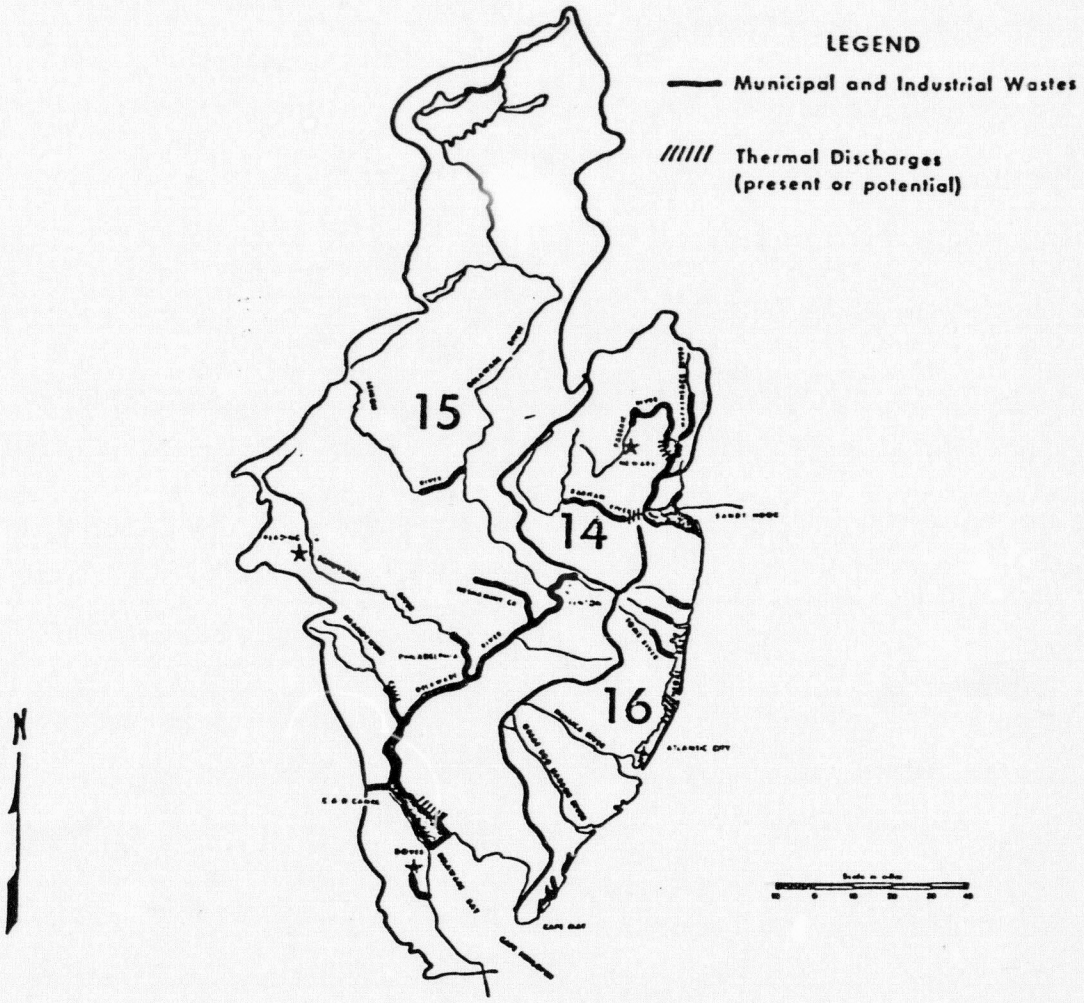
[1]Virginia to Maine coastal drainage basin area.



AREAS 14, 15, AND 16

Figure II-44. Water Quality Problem Areas
(Adapted from NAR Water Resources Study, 1972)

All major water bodies are currently receiving treated and untreated nonindustrial and industrial wastes and, in the vicinity of population and industrial centers, are seriously degraded. Here again, the organic pollution from various sources is the most significant problem while the inorganic and combined sewer overflows are second. Tables II-17, II-18, and II-19 show the waste loads expected both before and after treatment through the year 2020 which does not include loading that may result from this proposed action. As in the New York area, the future nonindustrial waste loads will decrease under the existing abatement and implementation plans,[1] while the future industrial waste loads will increase.

Other problems in this area are similar to those of New York. Septic tanks and cesspools are used by more than 500,000 separate housing units and will become increasingly unsatisfactory as density increases, especially in Area 16.[2] Implementation of state legislation should correct these problems. Thermal pollution is indicated in Figure II-44 and, since power requirements are expected to increase with population, this will become a more significant problem in the future unless the designers improve present equipment. Recreational boating constitutes a significant source of pollution in the more than 300 marinas in this area. Oil, litter, and sewage are the accompanying problems here. Commercial shipping at the major harbor areas causes problems with oil spills and overboard waste disposal. Channel dredging creates

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[1] State and Federally regulated.
[2] Coastal New Jersey.

Table II-17. Present and Future Organic Waste Loads--Planning Area No. 14

Year	Non-Industrial Waste Load[1] P.E.[3] (000)		Industrial Waste Load[2] P.E. (000)		Total Waste Load P.E. (000)	
	Before Treatment	After Treatment[4]	Before Treatment	After Treatment[4]	Before Treatment	After Treatment
1960	4,110[5]	2,170	11,700	8,170	15,810	10,340
1980	5,020	750	25,900	3,900	31,000	4,630
2000	6,080	608	52,300	5,200	58,000	5,840
2020	7,300	730	105,000	10,500	112,000	11,200

[1]Includes waste loads from municipalities, institutions and Federal installations.

[2]Includes the waste loads from the six major water-using two digit Standard Industrial Code groups.

[3]Population Equivalent - the amount of waste (BOD) equal to that produced each day by one person (0.17 lbs/person/day).

[4]This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000, and 2020 without the proposed action.

[5]Includes 1,590,000 persons not served by non-industrial waste collection systems.

(From NAR Water Resources Study, 1972)

Table II-18. Present and Future Organic Waste Loads--Planning Area No. 15

Year	Non-Industrial Waste Load[1] P.E.[3] (000) Before Treatment	Non-Industrial Waste Load[1] P.E.[3] (000) After Treatment[4]	Industrial Waste Load[2] P.E. (000) Before Treatment	Industrial Waste Load[2] P.E. (000) After Treatment[4]	Total Waste Load P.E. (000) Before Treatment	Total Waste Load P.E. (000) After Treatment
1960	6,350[5]	900	11,800	1,800	18,150	2,700
1980	7,980	1,200	31,500	4,700	39,500	5,900
2000	10,100	1,000	81,000	8,000	92,000	9,200
2020	12,600	1,260	188,000	18,800	201,000	20,000

[1]Includes waste loads from municipalities, institutions and Federal installations.

[2]Includes the waste loads from the six major water-using two digit Standard Industrial Code groups.

[3]Population Equivalent - the amount of waste (BOD) equal to that produced each day by one person (0.17 lbs/person/day).

[4]This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000 and 2020 without the proposed action.

[5]Includes 1,590,000 persons not served by non-industrial waste collection systems.

(From NAR Water Resources Study, 1972)

Table II-19 Present and Future Organic Waste Loads Planning Area No. 16

Year	Non-Industrial Waste Load[1] P.E.[3](000) Before Treatment	Non-Industrial Waste Load[1] P.E.[3](000) After Treatment[4]	Industrial Waste Load[2] P.E. (000) Before Treatment	Industrial Waste Load[2] P.E. (000) After Treatment[4]	Total Waste Load P.E. (000) Before Treatment	Total Waste Load P.E. (000) After Treatment
1960	1,450[5]	788	598	299	2,050	1,090
1980	824	125	1,390	200	2,200	300
2000	1,030	103	3,540	360	4,600	500
2020	1,270	127	8,190	820	9,500	950

[1]Includes waste loads from municipalities, institutions and Federal installations.

[2]Includes the waste loads from the six major water-using two digit Standard Industrial Code groups.

[3]Population Equivalent - the amount of waste (BOD) equal to that produced each day by one person (0.17 lbs/person/day).

[4]This is considered to be a result of actual treatment practice carried out in 1960 and then secondary treatment for 1980, 2000 and 2020 without the proposed action.

[5]Includes 1,590,000 persons not served by non-industrial waste collection systems.

(From NAR Water Resources Study, 1972)

problems of turbidity and resuspension of pollutants in and around the harbor areas. Rural and urban runoff are also problems in this area and carry the same pollutants mentioned earlier.

In Area 14, most of the fresh water needed to supply public and industrial users is obtained from surface sources (>75 percent); a small portion is diverted from Area 15. Area industry uses publicly supplied fresh water in addition to the brackish water and self-supplied fresh water drawn from ground water aquifers. Since Area 14 encompasses the Piedmont, Appalachian, and a small portion of the Coastal Plain provinces, a variety of aquifers are involved as described in Section II.A.4 . Depression cones have formed in those portions of Middlesex, Union, and Essex Counties in which industry has over-utilized the available ground water. Salt water encroachment in these areas now limits its utilization (Anderson, 1968; Jablonski, 1968; Nichols, 1968). In 1972, 513 mgd were used for public supply and 1046 mgd for industrial supply (278 mgd of self-supplied fresh water, 60 mgd of publicly supplied fresh water, and 708 mgd of brackish water). The average annual runoff for Area 14 is 2580 mgd of which 852 mgd (33 percent) are currently available.

Future needs are expected to increase in both the public and industrial categories. By providing additional storage and treatment capacity and increasing the number of intakes and pumping stations, 1496 mgd or 58 percent of the average annual runoff could be made

available. Additional diversion from Area 15 might be required for public fresh water supply in later years. Limited fresh water resources would also force industry to depend more heavily on publicly supplied fresh water since private development and usage could be unfeasible.

In Area 15 most of the fresh water needed to supply public and industrial users is obtained from surface sources (>75 percent). Industry requirements, which are the highest in the entire NAR study area, are met by brackish water and publicly and self-supplied fresh water sources. In 1972, 800 mgd were used for public supply and 1652 mgd for industrial supply (1000 mgd of self-supplied fresh water, 119 mgd of publicly supplied fresh water, and 533 mgd of brackish water). The average annual runoff is 13,200 mgd of which 4840 mgd are currently available.

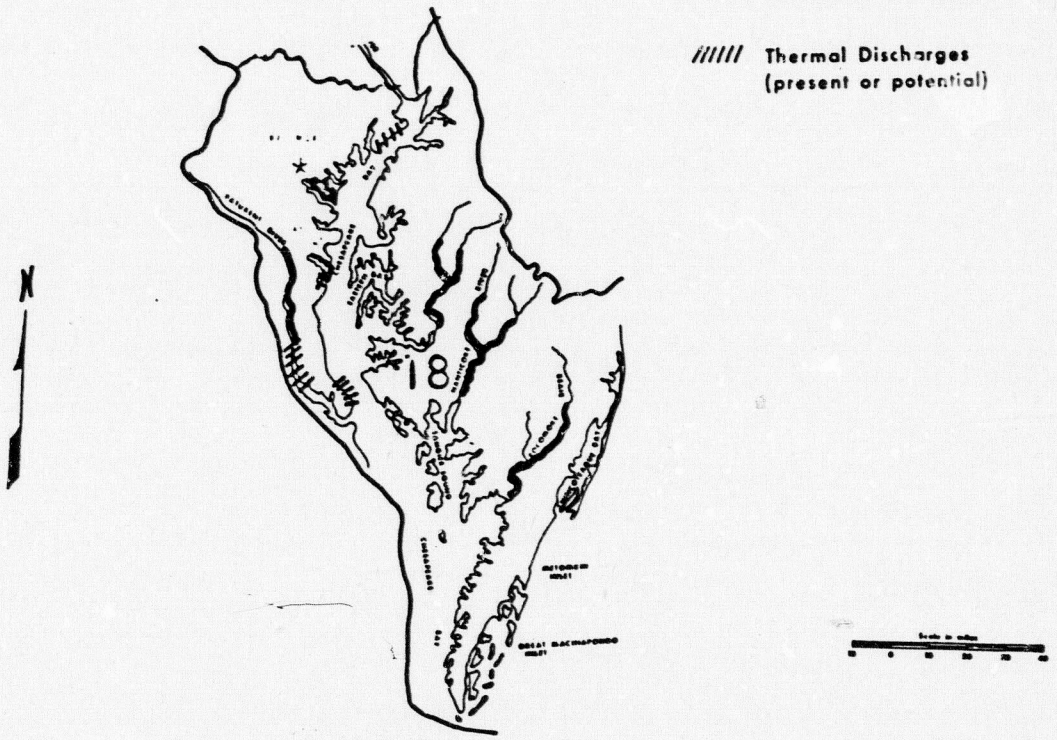
Future needs of this area are expected to increase in both the public and industrial categories. By providing additional storage and treatment capacity and increasing the number of wells, intakes, and pumping stations, 7562 mgd or 57 percent of the average runoff could be made available. Salt water encroachment is a potential limiting factor for the increased use of ground water in communities bordering the Delaware River. (At present no wells other than those in Lewes, Delaware, have reported intrusion.)

In Area 16, most of the fresh water needed to supply public and industrial users is obtained from ground water sources (>70 percent). Industry needs in the Area are very low and require only brackish water and self-supplied fresh water. In 1972, 86 mgd were used for public supply and only 28 mgd for industrial supply (3 mgd of self-supplied fresh water and 25 mgd of brackish water). The average annual runoff is 2450 mgd of which 845 mgd (34 percent) are currently available. Due to the extreme seasonal fluctuations in population (summer tourists), fresh water availability has been strained, especially in coastal areas and Cape May County in which salt water intrusion is a real threat.

Both public and industrial needs are expected to increase in the future. By providing additional storage capacity, increasing the number of intakes and pumping stations, and developing ground water supplies, 1065 mgd or 43 percent of the average runoff could be made available. Rhodehamel (1970) suggests that proper utilization of water from the Pine Barrens could support the future growth of the resort communities, industrialized areas along the Delaware River, and southern New Jersey communities as well.

c. Southern Delaware, Maryland, and the Eastern Shore of Virginia

The area considered is shown in Figure II-45 and the water systems carrying municipal and industrial wastes and subject to thermal discharges are indicated.



AREA 18

Figure II-45. Water Quality Problem Area
(Adapted from NAR Water Resources Study, 1972)

This area as a whole is sparsely settled, implying that it does not suffer as much from population-related pollution problems as do the earlier mentioned areas. The nonindustrial load is approximately 20 percent of the load while the industrial load is approximately 5 percent. At present the water in the area is used for municipal and industrial water supply. A portion of this is supplied from "water-rich" northern areas and is used very extensively for recreation purposes since it is so convenient to densely-populated urban areas. Commercial fishing is important though some environmental stress is beginning to affect the species diversity. The Port of Baltimore and other smaller ports in Chesapeake Bay provide commercial navigation outlets. Water is also needed for power generation and irrigation, both of which are expected to increase.

Table II-20 shows the present and predicted waste loads both before and after treatment through the year 2020 (without the proposal). Here also, the present abatement and implementation plans will significantly curtail both the nonindustrial and industrial pollution loads. Septic tanks and cesspools are problems as are thermal sources. Recreational boating, commercial shipping, and rural and urban runoff add substantial amounts of oil, sewage, litter, fertilizers, pesticides, and sediment to surface waters.

Over 80 percent of the fresh water needed to supply public and industrial users in the Area is obtained from surface water sources,

Table II-20. Present and Future Organic Waste Loads--Planning Area No. 18

Year	Non-Industrial Waste Load[1] P.E.[3] (000)		Industrial Waste Load[2] P.E. (000)		Total Waste Load P.E. (000)	
	Before Treatment	After Treatment[4]	Before Treatment	After Treatment[4]	Before Treatment	After Treatment
1960	2,185	423	687	516	2,872	939
1980	2,767	415	1,531	230	4,298	645
2000	3,445	516	3,543	532	6,988	1,048
2020	4,261	639	7,825	1,172	12,086	1,811

[1]Total population equivalents (PE) based on OBE/projection of population.

[2]Projections made by multiplying (present, 1960, estimated gross waste load generated) x (OBE) projected output index). Based on total Standard Industrial Code groups for the following 2 Digit Groups: 20, 22, 26, 28, 29, 33, and 10-14.

[3]Population Equivalent-the amount of waste (BOD) equal to the amount produced each day by one person (0.17 lbs/person/day).

[4]Present treatment practices for 1960, secondary treatment for 1980, 2000, and 2020 without the proposal.

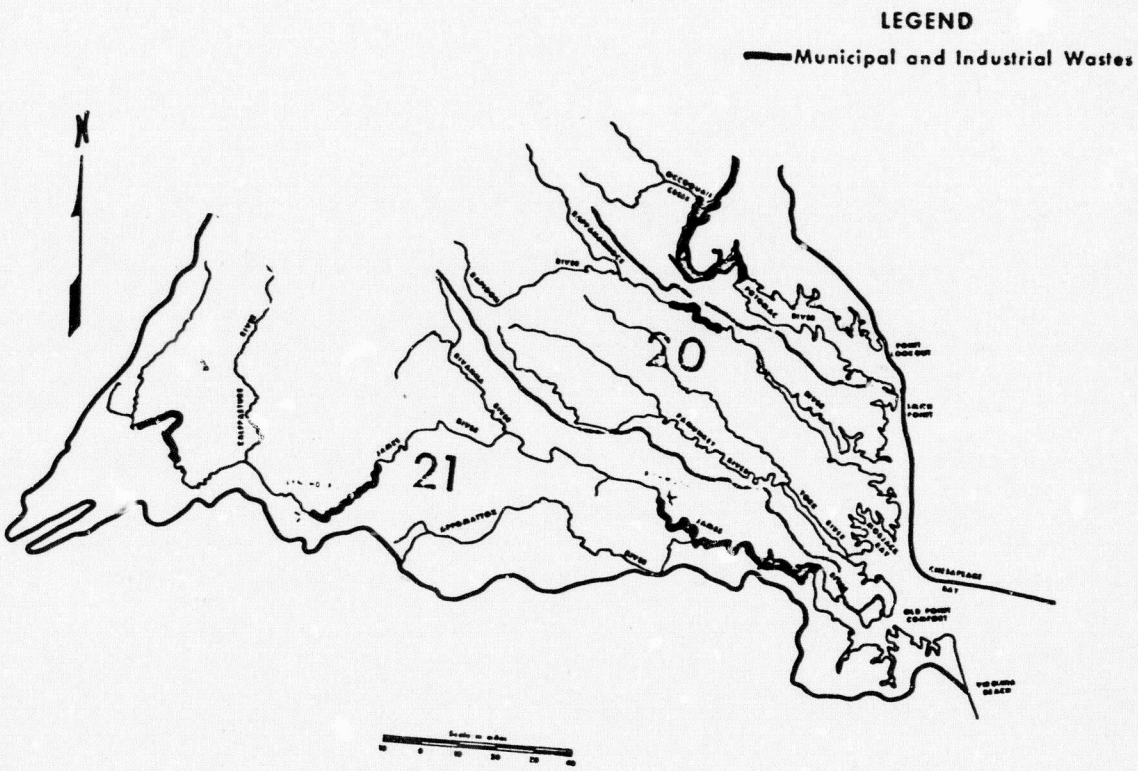
(From NAR Water Resources Supply Study, 1972)

although on the Delmarva Peninsula, 90 percent is obtained from ten underground aquifers. Diversion from the lower Susquehanna also accounts for a small percentage. Area industry uses brackish water, publicly and self-supplied fresh water, and waste water. (The primary metal industry uses sewage treatment plant effluent.) In 1972, 260 mgd were used for public supply and 1173 mgd for industrial supply (154 mgd of self-supplied fresh water, 45 mgd of publicly supplied fresh water, 854 mgd of brackish water, and 120 mgd of waste water). The average annual runoff is 5500 mgd of which 1085 (20 percent) are currently available.

Both public and industrial needs are expected to increase in the future. Surface water sources for industrial use may require regulation. This might involve either the limitation of withdrawals or cost-sharing with the public sector of the facilities needed to maintain flow in the Area's rivers. Cushing et al. (1973) suggests that the ten principal aquifers of the Delmarva Peninsula are underutilized; 1500 mgd could be developed perennially which would be ten times the usage of 1970. Providing additional storage capacity, increasing the number of intakes and pumping stations, and additional transfer of the lower Susquehanna could also help provide the needed supplies.

d. Virginia

The area considered lies along the western shore of Chesapeake Bay as shown in Figure II-46 and water systems that carry



AREA 20 and 21

Figure II-46. Water Quality Problem Area
(Adapted from NAR Water Resources Study, 1972)

municipal and industrial waste are indicated. These systems supply water for municipal and industrial needs, substantial recreational purposes, commercial fishing, power generation, and irrigation. The Hampton Roads area also supplies excellent harbor facilities. Tables II-21 and II-22 show the present and predicted waste loads both before and after treatment through the year 2020 (without the proposal). Industrial and nonindustrial waste loads account for approximately 50 percent of the total organic wastes generated in the region. In both Area 20 and 21, the rivers and estuaries receive cooling water from steam generating power plants; silt, pesticides, oil, and nutrients from rural and urban runoff including the overflow from combined sewers; and the normal discharges from sewage treatment plants and industrial outfalls. The pollution arising from these sources has caused the closing of shellfish areas and a lessening of the aesthetic, recreational, and most other values of the water resources.

In Areas 20 and 21, most of the fresh water needed to supply public and industrial users is obtained from surface sources (>80 percent). Industry uses brackish water and publicly and self-supplied fresh water. In 1972, in Area 20, 18 mgd were used for public supply and 92 mgd for industrial supply (50 mgd of self-supplied fresh water, 2 mgd of publicly supplied fresh water, and 40 mgd of brackish water). In Area 21, 185 mgd were used for public supply and 454 mgd for

Table II-21. Present and Future Organic Waste Loads (without the proposed action) Area No. 20

Year	Non-Industrial Waste Load[1] P.E.[3] (000) Before Treatment	Non-Industrial Waste Load[1] P.E.[3] (000) After Treatment[4]	Industrial Waste Load[2] P.E. (000) Before Treatment	Industrial Waste Load[2] P.E. (000) After Treatment[4]	Total Waste Load P.E. (000) Before Treatment	Total Waste Load P.E. (000) After Treatment
1960	72	20	215	199	287	219
1980	382	57	612	92	994	149
2000	518	52	1,525	153	2,043	205
2020	737	74	4,628	463	5,365	537

[1]Includes waste loads from municipalities, and Federal installations.

[2]Includes the waste loads from the six major water-using two-digit Standard Industrial code groups.

[3]Population Equivalent-the amount of waste (BOD) equal to that produced each day by one person (0.17 lbs/person/day).

[4]This is considered to be the result of actual treatment practices carried out in 1960 and then secondary treatment for the entire population for 1980, 2000, and 2020.

(From NAR Water Resources Supply Study, 1972)

Table II-22. Present and Future Organic Waste Loads (without the proposed action) Area No. 21

	Non-Industrial Waste Load[1] P.E.[3] (000)		Industrial Waste Load[2] P.E. (000)		Total Waste Load P.E. (000)	
Year	Before Treatment	After Treatment[4]	Before Treatment	After Treatment[4]	Before Treatment	After Treatment
1960	1,097	658	2,637	1,014	3,734	1,672
1980	2,057	308	6,790	1,020	8,847	1,328
2000	2,583	388	17,432	2,620	20,015	3,008
2020	3,198	479	40,004	6,000	43,202	6,479

[1]Includes waste loads from municipalities, institutions, and Federal installations.

[2]Includes the waste loads from the six major water-using two-digit Standard Industrial Code groups.

[3]Population Equivalent-the amount of waste (BOD) equal to that produced each day by one person (0.17 lbs/person/day).

[4]This is considered to be the result of actual treatment practices carried out in 1960 and then secondary treatment for the entire population for 1980, 2000, and 2020.

(From NAR Water Resources Study, 1972)

industrial supply (397 mgd of self-supplied fresh water, 21 mgd of publicly supplied fresh water. and 36 mgd of brackish water). The average annual runoff for Area 20 is 3680 mgd of which only 78 mgd (2 percent) are currently available. For Area 21, the average is 7450 mgd of which 674 mgd (9 percent) are available. Both public and industrial needs are expected to increase in the future. By providing additional storage and treatment capacities, increasing intakes and pumping stations, and developing ground water supplies, these needs can be met. Area 20 has a potential for developing 1702 mgd or 46 percent of the average runoff and Area 21 could develop 2938 mgd or 39 percent of its average runoff.

An overview of water quality in the Atlantic region as a whole may be found in the Final EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Volume 1, Pages 501-508.

E. Air Quality

In the years since passage of the Clean Air Act Amendments of 1970, there has been a continued improvement in the quality of the air in most of the nation. This is exemplified in the Mid-Atlantic area that is expected to be influenced by this proposed action. The Amendments required states to submit to the Environmental Protection Agency for approval implementation plans for achieving the national ambient air quality standards by the 1975-1977 deadlines. (Tables II-23 and II-24 indicate the national standards and the pollutants' sources.) All the plans for the Mid-Atlantic States have been approved. Some States--Delaware, Maryland, and New York--have established even stricter standards for some of the pollutants. Under all state plans, polluters are required to install control technology or take other steps to reduce emissions so as to meet the national ambient standards. New plants or those undergoing modification must use the "best demonstrated" technology. Figure II-47 indicates the various city and county air quality sampling sites in those portions of the Mid-Atlantic states of concern in this proposal.

1. New York[1]

For sulfur dioxide, the existing values are below the standard in all the regions which may be affected by this proposed action. Some temporary excesses occur in the Albany and the Manhattan

[1]Data taken from the 1972 and 1974 air quality summaries.

Table II-23. National Ambient Air Quality Standards

Parameter	Standard[1] Primary	Secondary
Particulates		
Annual Geometric Mean	75 $\mu g/m^3$	60 $\mu g/m^3$
24-hour average	260 $\mu g/m^3$	150 $\mu g/m^3$
Sulfur Dioxide (SO_2)		
Annual Arithmetic Mean	80 $\mu g/m^3$ .03 ppm	60 $\mu g/m^3$ .02 ppm
24-hour average	365 $\mu g/m^3$ .14 ppm	260 $\mu g/m^3$ .1 ppm
3-hour average	N.A.	1300 $\mu g/m^3$ 0.5 ppm
Nitrogen Dioxide (NO_2)		
Annual Arithmetic Mean	100 $\mu g/m^3$ 0.05 ppm	100 $\mu g/m^3$ 0.05 ppm
Carbon Monoxide (CO)		
8-hour average	10 mg/m^3 9 ppm	10 mg/m^3 9 ppm
1-hour average	40 mg/m^3 35 ppm	40 mg/m^3 35 ppm
Hydrocarbons		
3-hour average	160 $\mu g/m^3$	160 $\mu g/m^3$
6-9 a.m. average	.24 ppm	.24 ppm
Photochemical Oxidants (as O_3)		
1-hour average	160 $\mu g/m^3$ .08 ppm	160 $\mu g/m^3$ .08 ppm

[1]Standards quoted are maximum values. Primary standards define the level of air quality, which, with a margin of safety, will protect the public health. These standards are to be enforced by 1975-1977. Secondary standards are more restrictive and based on public welfare, i.e., aesthetics. The enforcement date on these has not been established.

Table II-24. Description for the Major Air Pollutant Sources

Pollutant	Description
Particulates	Solid and liquid particles in the atmosphere, including dust, smoke, mists, fumes, and spray from many sources.
Sulfur dioxide	Heavy, pungent, colorless gas formed from combustion of coal, oil, and other.
Nitrogen dioxide	Brown, toxic gas formed from fuel combustion. Under certain conditions, it may be associated with ozone production.
Carbon monoxide	Invisible, odorless gas formed from combustion of gasoline, coal, and other fuels; largest manmade fraction comes from automobiles.
Hydrocarbons	Liquid and gaseous components of gasoline and other fuel oils; one component of photochemical smog.
Photochemical oxidants (as O_3)	Pungent, colorless toxic gas; one component of photochemical smog.

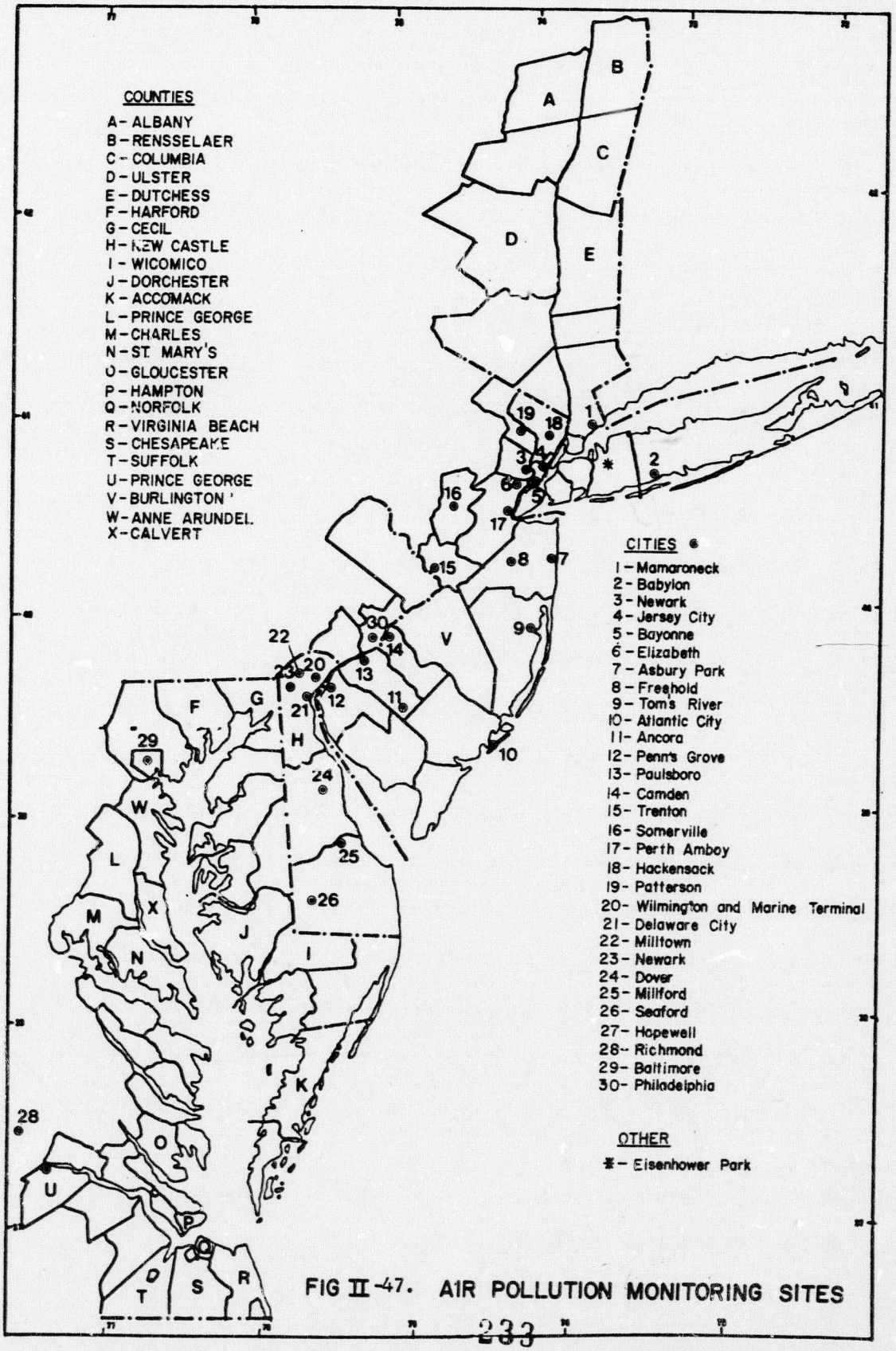


FIG II-47. AIR POLLUTION MONITORING SITES

Triboro area due to stationary power sources. During the winter months an increase was noted at the Roosevelt Island station, but this was due to the high sulfur fuel temporarily used. The annual average standards for particulate matter were substantially exceeded in 1972 in many areas because of stationary power sources, construction activities, and so forth. Albany, Ulster County, and Babylon with averages of 118$\mu g/m^3$, 124$\mu g/m^3$, and 124$\mu g/m^3$, respectively, were especially susceptible. The one-hour average standard for ozone was exceeded in all areas for 1974. The highest recordings occurred in Babylon, 0.207ppm, and Roosevelt Island, 0.185ppm, though other areas also exceeded the standard many times during the year. (Ozone and other photochemical oxidants are artifacts of other pollutants acted upon by sunlight. The original pollutants may be generated in one area, and the oxidants formed downwind so that it is often difficult to determine the source.) The nitrogen dioxide standards were exceeded in New York and showed upward trends in Mamaroneck during 1974. Other areas exhibited little or no change and were below the national standard. For carbon monoxide, all sites remained fairly constant and well below the national one-hour average. However, the eight-hour average standard for carbon monoxide was exceeded many times in most areas, for example, Babylon--9 times, Eisenhower Paek--125 times, Roosevelt Island--13 times, and Mamaroneck--61 times. The high level of traffic and the design of the streets

allow carbon monoxide to collect causing these temporary excess levels. Eisenhower Park was the only station for which long-term hydrocarbon data was available. For the period January 1, 1972 through December 31, 1974 the values there ranged between 2 and 2.5ppm.

2. New Jersey[1]

In 1974, the primary standards for the three sulfur dioxide measurements were never exceeded; only in Elizabeth and Camden did the values equal the standard (0.03ppm). The levels of nitrogen dioxide in the areas sampled--Bayonne, Camden, Elizabeth, and Newark--were also below or just above the standard (Elizabeth--0.052ppm, Newark--0.05ppm). Hydrocarbon level standards were exceeded on all days for which data was available.

Table II- 25. 1974 Hydrocarbon levels for New Jersey

Site	Maximum 6-9 A.M. Average	Primary Standard (0.24ppm)
Bayonne Lab	4.5ppm (258)	
Camden Lab	3.3ppm (262)	
Elizabeth Lab	4.7ppm (273)	
Newark Lab	3.2ppm (288)	

Note: Total hydrocarbons were measured; non-methane portion is considered to be 35 percent of the total. The number in parentheses is the number of times the value of the standard was exceeded.

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[1] Data taken from the 1974 air quality reports.

Ozone standards were also exceeded many times throughout the year.

Table II-26. 1974 Ozone levels in New Jersey

Site	Maximum One-Hour Average	Primary Standard (0.08ppm)
Bayonne Lab	0.208 (290)	
Camden Lab	0.199 (243)	
Elizabeth Lab	0.098 (20)	
Newark Lab	0.140 (59)	
Ancora	0.18[illegible] (317)	
Asbury Park	0.176 (124)	
Jersey City	N.A. (N.A.)	
Somerville	0.196 (103)	
Trenton	0.231 (181)	

Note: The number in parentheses is the number of times the value of the standard was exceeded.

The eight-hour standard for carbon monoxide was exceeded in most of the twenty areas sampled by values ranging from 9.4ppm to 26.0ppm for as many as 732 (Elizabeth) eight-hour periods during the year. The one-hour standard for carbon monoxide was seldom exceeded in these areas except for Elizabeth (two hours) and Atlantic City (two hours). The annual averages for suspended particulates were lower than the standards in all except the Newark ($133\mu g/m^3$), Jersey City ($82\mu g/m^3$), and Carteret ($70\mu g/m^3$) areas. In addition, the standard for the maximum 24-hour concentration was contravened in Bayonne, East Orange, South Amboy, Woodbridge, South Brunswick, and Secaucus.

3. Delaware[1]

For 1974, the levels of sulfur dioxide in Delaware were below the secondary national ambient standards. Recent downtrends in sulfur dioxide levels, however, were halted due to the

[1]Data taken from the 1974 air quality summaries.

increase in use of higher sulfur fuel. Particulate levels were also below the primary national standards except in downtown Wilmington (85$\mu g/m^3$) and at the Marine Terminal (141$\mu g/m^3$). This was due to the unpaved parking lots and shoulders, construction sites, and so on. Both of these areas did show downward trends in 1974, as did the other sampling sites. Oxidants exhibited the same problems here as in all other states. No measurements were available for hydrocarbons or nitrogen oxides.

4. Maryland[1]

The annual mean standard for sulfur dioxide was not exceeded anywhere during 1973 although the areas in Baltimore and Prince Georges County did exceed the state's yearly average adverse level. There was a statewide decrease in particulate levels, all of which are below the primary standard. The nitrogen dioxide levels in all areas were also below the standard. Carbon monoxide, hydrocarbons, and oxidants were only measured in a few areas (Anne Arundel, Baltimore City, and Prince Georges). The carbon monoxide averages were below the national standards. Hydrocarbon averages exceeded the standards throughout the year: Anne Arundel-5013$\mu g/m^3$, 160 times; Baltimore City-5754$\mu g/m^3$, 222 times; Prince Georges-4359ppm, 243 times. The oxidant levels in Prince Georges County were also often above the standards: 392$\mu g/m^3$, 49 times. These three pollutants present considerable problems in metropolitan Baltimore, Prince Georges, and St. Marys Counties.

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[1]Data taken from the 1973 air quality report.

5. Virginia[1]

In 1974, none of the sulfur dioxide annual averages was above the national standard. (The 24-hour primary standard was exceeded three times in Hopewell and twice in the industrial area of Chesapeake.) Downward trends in suspended particulates were observed in all areas except the Hampton-Newport News area. In most areas the levels were below those of the national secondary standard. Carbon monoxide and oxidant levels were only measured in four of the cities in the affected areas. The one-hour carbon monoxide standards were not exceeded although the eight-hour standards were (Hampton-10.8$\mu g/m^3$, Norfolk-11.3$\mu g/m^3$). A slight downward trend is in evidence. The oxidant levels were oftentimes above the standards (Hampton-0.195ppm, 147 hrs; Norfolk-0.15ppm, 107 hrs; Richmond-0.095ppm, 8 hrs). Upward trends are indicated.

6. Philadelphia[2]

In recent years the air quality of Philadelphia has been improving. There has been a significant decrease in the levels of sulfur dioxide because of the limits imposed on the sulfur content of fuel oils. The variances granted recently because of the shortage of low sulfur fuel disrupted this downward trend so that the annual standards were approached at some

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[1]Data taken from the 1974 air quality report.

[2]Data taken from the emissions inventory and the 1974 air quality report.

stations. Levels of suspended particulates have also decreased. It has been recently demonstrated that mobile sources account for 90 percent of the particulate levels. Because of this, national standards may not be achieved even with full implementation of the present transportation plan. Carbon monoxide and hydrocarbon levels are below the national standards but show no definite downward trends. Better controls on both mobile and stationary sources should soon begin to lower these levels. Nitrogen dioxide levels which had been decreasing show a significant rise since 1972, probably because of the newer emission controls on automobiles. This should be rectified in 1974 and later model cars. Oxidants which had also been declining show a rise since 1973 due to the rise in nigrogen dioxide levels and possible influx from other areas.

An overview of air quality in the Atlantic coastal region as a whole may be found in the Final EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol. 1, pp. 508-509.

F. Biological Communities[1]

1. Offshore and Nearshore

a. Phytoplankton

Introduction

The phytoplankton community of the Mid-Atlantic area can be divided into three natural divisions: those found in the coastal salt ponds, the embayments, and the offshore waters.

Several environmental parameters other than current transport affect phytoplankton populations. Fish (1925) and Riley (1952) report that their reproduction and succession are, in addition, affected by temperature, light availability, nutrient levels, stability of the water column, and grazing pressures.

The phytoplankton community of the area is very diverse. Among the groups represented are diatoms, dinoflagellates, coccolithophorids, silicoflagellates, euglenoids, blue-green algae, and various microflagellates (Smayda, 1973). Although the floristic characteristics of inshore waters are fairly well known for certain geographic areas, very little is known for offshore waters. Species (Table II-27) most common in coastal waters from Cape Cod to Sandy Hook are listed in the publication by TRIGOM (1974). General taxonomic studies of phytoplankton in the region between Cape Cod and Cape Hatteras do not exist (Smayda, 1973).

[1] An overview of various aspects of biological communities of the entire Atlantic Coastal Region may be found in the Final EIS on the Proposed Increase in Oil and Gas Leasing of the Outer Continental Shelf, Volume 1, pages 197-216 (offshore), 415-431 (nearshore and onshore), 699-701 (significant and potential vulnerable resources), and 776 (endangered species).

Table II-27. Dominant Offshore Coastal Species of Phytoplankton from Cape Cod to Sandy Hook (TRIGOM, 1974)

Species	Seasons of Greatest Abundance
DIATOMS	
Skeletonema costatum	All year
Thalassionema nitzschoides	All year
Paralia sulcata	Fall - Winter
Cerataulina pelagica	Late Spring - Fall
Chaetoceros radians	Summer
C. curvisetum	Summer - Fall
C. decipiens	Spring - Summer
Leptocylindrus danicus	All year
Nitzschia longissima	Summer - Fall
Thalassiosira gravida	Summer - Fall
T. rotula	Summer - Fall
DINOFLAGELLATES	
Peridinium trochiodeum	Spring - Fall
Prorocentrum scutellum	Summer - Fall
SILICOFLAGELLATES	
Distephanus speculum	Spring

Modest guides exist for Narragansett Bay (Lackey, 1961; Wood and Lutes, 1967), Chesapeake Bay (Griffith, 1961), dinoflagellates for coastal New Jersey (Martin, 1929), dinoflagellates and micro-flagellates for the Woods Hole region (Lackey, 1940; Dashu, 1947; Hulburt 1957, 1965), dinoflagellates for coastal New York (Freudenthal and Lee, 1963), and diatoms for coastal waters off Beaufort, North Carolina (Manly, 1953; Hustedt, 1955).

While the listed studies are specific to geographic area, evidence according to Smayda (1973) suggests widespread distribution of species within the Mid-Atlantic area. Studies not specifically of the Mid-Atlantic area are included, in lieu of total absence of data, so that population dynamics of the area can be better understood.

Smayda (1973) also states that the micro-flora of this region is very inadequately known and that great numbers of new species are still being described. In addition, he recognizes a need for a taxonomic guide covering the east coast. Descriptions of many, smaller-sized species of phytoplankton are lacking and prevent adequate examination of the taxonomy and floristics of the coastal phyto-plankton between Cape Cod and Cape Hatteras (Smayda, 1973).

Coastal Salt Ponds and Embayments

The coastline of the Mid-Atlantic states is characterized by numerous embayments of various sizes. In most cases, the embayments are separated from coastal waters by barrier

islands with an inlet through the island as the only exchange with coastal waters. Due to this "limited" exchange and the accumulation of plant nutrients from fresh water runoff and from offshore areas, the coastal salt ponds and embayments are nutrient rich and consequently high productivity areas (TRIGOM, 1974). Fresh water runoff often produces a head of fresh water with a seaward transport and results in a two-layer system which allows less dense water to flow seaward at the surface and dense water from offshore to flow in along the bottom. Nutrients are thereby introduced from offshore (Conover, 1961; Hulburt, 1956).

Although salt ponds and embayments are high productivity areas, discussion of their life systems in this section will be limited to the associated phytoplankton communities.

Phytoplankton productivity, species composition, and seasonal variation within inshore environs often varies with location and situation (Tables II- 28 and II- 29). Areas which have been investigated in these regards include Oyster Pond, Massachusetts (Emery, 1969); Great Pond, Massachusetts (Barlow, 1956; Hulburt, 1956); and Vineyard Sound (Fish, 1925; Lillick, 1937).

A dominance of diatoms and dinoflagellates are reported for Vineyard Sound. Skeletonema costatum, Rhizosolenia spp., Leptocylindrus spp., Corethron hystrix, Nitzschia seriata, Thalassionema nitzschioides, Thalassiosira nordenskioeldii, Chaetoceros spp.,

Table II- 28. Mean Standing Crop of Phytoplankton for Selected Areas (Adapted from Smayda, 1973). Legend: (*) Smayda, 1957; (+) Riley and Conover, 1967; others from Hulburt, 1963.

	n	Mean (Cells/L)
COASTAL SALT PONDS		
Great South Bay	47	107×10^6
Moriches Bay (Summer 1956-58)		
Senix Creek (June, September)	3	114×10^6
Salt Pond, 1950	13	223×10^6
Uncatena Island Pond, 1950	7	9.2×10^6
BAYS AND SOUNDS		
*Lower Narragansett Bay, 1954-55		6.7×10^6
+Long Island Sound, 1952-55		
Western Region		1.7×10^6
Central Region		1.0×10^6
Eastern Region		0.2×10^6
*Block Island Sound, 1949		0.5×10^6
*Vineyard Sound, 1935-36		0.02×10^6

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Table II-29. Mean Annual Primary Production for Phytoplankton for Selected Areas (Adapted from Smayda, 1973)

Region	Production ($gm\ C/m^2/yr$) Gross	Net	Source
COASTAL SALT PONDS			
Massachusetts			
Oyster Pond	350-400		(2) (6)
Eel Pond (11 months)			
a) from p CO_2	--	15	(10) (19)
b) from chlorophyll	80	--	(10) (19)
Rhode Island			
Charlestown-Green Hill Pond			
a) from PO_4 changes	--	28	(1) (3)
b) from O_2 changes	138	51	(9) (17)
Connecticut			
Niantic River	--	41	(4) (10)
LONG ISLAND BAYS			
Moriches Bay	--	56	(5) (12)
EAST BAY-MIDDLE BAY			
a) Estuarine (surface)	--	128	(3) (9)
b) Coastal (surface)	--	80	(3) (9)
c) Coastal (euphotic zone)	--	340-500	(3) (9)

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Table II-29. Continued.

OPEN COASTAL WATERS			
Long Island Sound	470	205	(7) (14)
Block Island Sound	7365	285	(6) (13)
New York Bight (Long Island)	--	340-550	(3) (9)
CONTINENTAL SHELF (OFF NEW YORK, NEW JERSEY			
Inshore (50 m depth)	160	--	(8) (15)
Intermediate (100-200 m)	135	--	(8) (15)
Offshore (>1000 m)	100	--	(8) (15)
SARGASSO SEA (>5000 m)	78	--	(8) (15)

Sources: (1) Conover, 1961; (2) Emery, 1969; (3) Mandelli, Burkholder, Doheny, and Brody, 1970; (4) Marshall, 1970; (5) O'Connor, 1972; (6) Riley, 1952b; (7) Riley, 1956; (8) Ryther and Yentsch, 1958; (9) Smayda, 1961; (10) Teal, 1967

Peridinium spp., Prorocentrum spp., and Distephanus speculum dominate during the summer months followed by a dominance of Skeletonema costatum, Rhizosolenia alata, Nitzschia seriata, and Chaetoceros spp. in the fall. Winter dominants include Rhizosolenia spp., Thalassiosira nordenskioeldii, and Prorocentrum spp., while spring dominants include Guinardia flaccida, Thalassionema nitzschioides, Chaetoceros and Peridinium spp.

Phytoplankton in Green Hills Pond, Rhode Island, has been investigated by Conover (1961) and Smayda (1961) and Niantic River, Connecticut, by Marshall (1960, 1967, 1970) and Marshall and Wheeler (1965). Phytoplankton in Narragansett Bay has been extensively studied by Ferrara (1953), Smayda (1957), Pratt (1959, 1965), Martin (1965), and Krout (1971). Some species that dominate the winter months at Narragansett Bay were found to include Skeletonema costatum, Asterionella japonica, Detonula confervacea, Thalassiosira nordenskioeldii, and Leptocylindrus spp. followed by Nitzschia seriata, Gyrodinium spp., Peridinium spp., Skeletonema costatum, and Leptocylindrus spp. in the spring. Summer dominants include Asterionella japonica, Thalassiosira spp., Rhizosolenia fragilissima, Nitzschia seriata, Gyrodinium spp., Peridinium trochordeum, and Prorocentrum gracile.

Several phytoplankton studies also exist for the embayments along the south shore of Long Island. Composition of these bays has been studied by Tressler and Bere (1939), Ryther (1954), Ryther

et al. (1958), Hulburt (1963), Lackey (1963, 1967), Barlow and Stafford (1968), Mandelli et al. (1970), and Levandowsky (1972). The major components of the phytoplankton for Block Island Sound have been described by Riley (1952a, 1952b) as well as Long Island Sound (TRIGOM, 1974). These studies include those of Riley (1952a, 1955, 1956, 1959, 1967), Conover (1956), Riley and Conover (1956, 1967), and Harris (1959).

At Block Island Sound winter dominants include the diatoms Skeletonema costatum, Thalassionema nitzschioides, Asterionella japonica, Thallassiosira subtilus, and Cylindrotheca closterium followed by Chaetoceros spp., Leptocylindrus spp., Cylindrotheca closterium, Nitzschia seriata, Asterionella japonica, and Guinardia flaccida in the spring. Summer dominants include Skeletonema costatum, Thalassionema nitzschioides, Chaetoceros spp., Cylindrotheca closterium, and Guinardia flaccida with Leptocylindrus spp., Nitzschia seriata, and Chaetoceros spp. dominating in the fall.

Winter dominants of diatoms for Long Island Sound include Skeletonema costatum, Thallassiosera spp., Thalassionema nitzschioides followed by the spring dominants Rhizosolenia spp., Thalassionema spp., Chaetoceros spp., Schroederella delicatula, Cerataulina pelagica, Leptocylindrus danicus, Asterionella japonica, Nitzschia seriata, and Peridinium trochiodeum. Summer dominants include Skeletonema costatum, Cerataulina pelagica, Chaetoceros curvisetus, Exuviella apora, Prorocentrum scutellum, and Distephanus speculum followed by a dominance of Thalassiosira spp., and Asterionella japonica in the fall.

Raritan Bay and New Jersey Coast

Phytoplankton composition and dynamics of Raritan Bay have been described by Patten (1961a, 1961b, 1962) and in Sandy Hook by Kawamura (1966). They found that the diatoms (*Skeletonema costatum*, *Thalassiosira gravida*, and *Chaetoceros decipiens*) dominate during the spring and late summer months while *Nannochloris atomus* (Chlorophycean) and dinoflagellates (*Prorocentrum micans*, *Peridinium trochoideum*, *P. breve*, and *P. divaricatum*) and dinoflagellates dominate the summer months. The dominant winter flora are the diatoms (*Nitzschia seriata*, *Leptocylindrus danicus*, *Rhizosolenia setigera*, *R. alata*, *Asterionella japonica*, *Thalassionema nitzschoides*, and *Guinardia flaccida*). The annual succession pattern is a diatom flowering in the spring followed by a dominance of *Nannochloris* and *Didymocystis* (green alga) which indicates the polluted conditions of Raritan Bay (Ryther and Dunstan, 1971; Smayda, 1973).

Red tide blooms frequently occur during the summer months and chlorophyll concentrations exceed 100 $\mu g/\ell$. During a bloom of the dinoflagellate, *Massartia rotundata* in 1959, the surface chlorophyll concentration was 663 $\mu g/\ell$ and during a *Nannochloris* bloom (4×10^8 cells/ℓ) the chlorophyll concentration was 165 $\mu g/\ell$ (Smayda, 1973). Smayda (1973) also reports that Raritan Bay has an abundant phytoplankton standing crop (chlorophyll) that exceeds concentrations reported for New England coastal waters. The frequent and large summer blooms of dinoflagellates and *Nannochloris* also reflect their highly eutrophic condition (Smayda, 1973).

Patten's (1961a, 1962) calculations revealed a reduction in phytoplankton diversity with increasing pollution and that species elimination is another adverse effect of pollution. Brackish species which characteristically contribute to diversity and productivity of upper extensions of estuaries were eliminated in Raritan Bay (Smayda, 1973).

Literature on phytoplankton dynamics of the New Jersey coastline is very scarce. Martin (1929) revealed 41 species of dinoflagellates in upper Barnegat Bay. He listed as "common" species Glenodinium danicum, Gymnodinium splendens, Peridinium trochoideum, Prorocentrum micans, and P. triangulatum. A more recent survey of dinoflagellates in upper Barnegat Bay (at Mantoloking) was conducted by Mountford (1967). He reported 26 species, four of which reached bloom proportions (Exuviaella lima, Gonyaulax spinifera, Prorocentrum triangulatum, and Skeletonema costatum).

Delaware Bay

Quantitative studies of phytoplankton in Delaware Bay are lacking as well as estimates of primary productivity (Smayda, 1973). Shuster (1959) and Cronin, Daiber, and Hulburt (1962) report that turbidity is high in Delaware Bay and that the potential for high phytoplankton productivity is offset.

Qualitative studies of phytoplankton for Delaware Bay are also scarce. Dinoflagellates have been surveyed by Martin (1929) and blooms caused by Amphidinium fusiforme and Gymnodinium splendens are reported by Martin and Nelson (1929) and Pomeroy, Haskins, and Ragotzkie (1956). They reported populations of approximately 4×10^8 cells/l and 280 to 360 u/l of chlorophyll.

Chincoteague Bay, Isle of Wight Bay and Assawoman Bay

Chincoteague Bay has a high standing crop of phytoplankton where summer chlorophyll-a values reached 40 mg/m^3 of water in the central portions of the Bay with generally lower readings near the inlets. Low values of chlorophyll-a were typical of the cold months with concentrations approximating 9 mg/m^3 of water (Boynton, 1973).

Incubation by natural light incubators demonstrated that there was a pronounced seasonal cycle in phytoplankton production that tends to follow the water temperature cycle. Gross photosynthesis ranged from 50 to 3,260 mg/cm^3/day and respiration from 50 to 1,040 mg/cm^3/day with lowest rates in February and March when temperature was lowest and highest rates in July and August when temperature was highest (Boynton, 1973). Relationship to nutrient availability was not given.

Phytoplankton in Chincoteague and adjoining bays is approximately twice as high as in North Carolina estuaries, six times that found in Long Island Sound and is considerably higher than ocean rates. The rates in Chincoteague Bay, however, are considerably lower than those reported for Texas Bays and polluted, nutrient rich, estuarine areas (Boynton, 1973).

Chesapeake Bay

In addition to the microflagellates or nannoplankton, (defined by Van Valkenburg (1973) as flagellated or coccoid photosynthetic planktonic organisms of under 10u in diameter) organisms included as Chesapeake Bay photoplankton include the diatoms, dinoflagellates, silicoflagellates, planktonic green and blue-green algae.

Estuarine literature describing the taxonomy of the above groups is practically nonexistent (Mulford, 1973) because most of the world-wide taxonomical works on phytoplankton have been done on oceanic species. Distribution of phytoplankton in Maryland's Chesapeake Bay has been represented on maps (Lippson, 1973) which indicate three areas of phytoplanktonic concentration (using chlorophyll-a concentration) in the Maryland waters. Chlorophyll-a concentration is between 30-60 (sometimes up to 100) mg/m^3 of water from Gibson Island to Turkey Point. Concentration is from 20-30 mg/m^3 of water from the South River to Gibson Island and is from 10-20 mg/m^3 from Lower Chesapeake to South River, and from Turkey Point to the Susquehanna River in the headwaters of the Chesapeake Bay.

Representative types of phytoplankton in the Chesapeake include:[1]

Diatoms (28 major species)	Chaetoceras affinis
Dinoflagellates (7 major species)	Gymnodinium splendens
Yellow-Brown Algae	Chrysonhromulina chito
Blue-Green Algae	Anocystis sp.
Green flagellate	Carteria multifilis
Silico flagellates	Dictyocha tripartita

[1]There are 36 important, dominant and widely distributed species out of a recorded total of 613 species for the entire Chesapeake Bay. Thus, approximately 6% of phytoplankton species account for the majority of phytoplankton biomass exclusive of nannoplankton (Mulford, 1973).

The Continental Shelf

Very little data exists with respect to phytoplankton in Mid-Atlantic coastal waters out to the continental shelf. Some data pertaining to phytoplankton composition and abundance for the area is reported by Hulburt (1963, 1966, 1970), Hulburt and Rodman (1963), Riley (1939), Riley and Gorgy (1948) and Riley, Stommel and Bumpus (1949).

Hulburt (1963, 1966, 1970) and Hulburt and Rodman (1963) found that phytoplankton populations off New York and New Jersey are comprised mainly of diatoms. During summers Rhizosolenia alata dominate and during winters Thalassionema nitzschoides, Skeletonema costatum, Asterionella japonica, and Chaetoceros socialis dominate. Spring dominants include Chaetoceros spp. and Nitzschia seriata and fall dominants include Thalassionema nitzschioides. Hulburt (1970) reports that floristic differences can exist between areas, for example, Skeletonema costatum to the south and Thalassiosira nordenskioeldii to the north of Long Island. Population density during November through March exceeds that during the other months, and there is also a considerable lower population level in these waters relative to the more enclosed systems. The prevalence of diatoms in these waters contrasts with the predominance of coccolithophores in the open ocean and Nannochloris in the embayments (Smayda, 1973).

As in the case for coastal New Jersey reported previously, phytoplankton data for coastal shelf waters of Maryland and Virginia is very scarce. Mulford (1963, 1964) and Mulford and Norcross (1971) report from studies at the entrance into Chesapeake Bay that diatoms dominate in spring and dinoflagellates during the summer and autumn. They list as important species: Ceratium (dinoflagellate) and the diatoms Chaetoceros, Rhizosolenia, and Skeletonema costatum.

b. Zooplankton

Introduction

Zooplankton, by definition, represent the animal component of the plankton. The group is divided into holoplankton if the animal either swims or floats in the water column for its entire life history; meroplankton if the animal is planktonic for only a portion of its life history; and tychoplankton for animals swept off the bottom. Almost every phylum in the animal kingdom is represented in the zooplankton (TRIGOM, 1974). Many commercially important species of fish and shellfish spend their egg and larval life stages as members of the meroplankton. According to Raymont (1966), many species of zooplankton can swim or change position vertically in the water column but are not able to move horizontally against tides and currents. Preliminary analysis of current research (Grant, 1976)[1] confirms the diel movement[2] of neuston.

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[1] BLM Environmental Studies Program data, 1976.

[2] Periodic movement according to light.

Raymont (1966) and most other workers categorize the plankton into two major communities, the neritic and oceanic. Neritic zooplankton is primarily coastal and seaward to approximtely the 100 m isobath. A specialized group (euryhaline) is restricted to estuaries. The euryhaline estuarine zooplankton include a large proportion of meroplankton and tychoplankton as well as a holoplankton component. Copepods are the most dominant members of this component. Common species include Acartia clausii, A. tonsa, Oithona brevicornis, and Tortanus discaudatus.

A large proportion of the neritic community is made up of meroplankton. Holoplanktonic species characteristic of coastal waters also predominate. The oceanic zooplankton is almost entirely holoplanktonic. The members of each group broadly overlap geographically, mainly due to water currents, depth, and topography which influence the seaward distribution of the neritic community (TRIGOM, 1974). Also, many species are too widely distributed to be categorized as either neritic or oceanic, for example, Calanus finmarchicus and Pleurobrachia pileus (Fish and Johnson, 1937). Raymont (1966), however, has suggested biological conditioning of the water by exocrines, vitamins, and other organic trace materials as a reason for the separation of the neritic and oceanic communities. Graham (1965) attributes importance to coastal currents for retaining the neritic component. Characteristic components of neritic zooplankton are copepoda, nauplii of cirripedes, and cladocerans. The oceanic forms include among others, the amphipods, euphausids, copepods, pteropods, and salps, and the chaetognatha.

Environmental Relationships

Salinity

Estuarine and neritic copepods have been classified by Jeffries (1967) and Jeffries and Alzara (1970) into five groups based on their ability to reproduce in various salt gradients: fresh water species, estuarine species which reproduce only in brackish water, estuarine and marine which reproduce in estuaries but also in coastal waters, euryhaline--marine species along coasts near the mouths of estuaries and stenohaline--marine species which reproduce only in open neritic waters. Members from each group form an overlapping distribution of species along the salt gradient of an estuary (Jeffries and Johnson, 1973). Variations exist depending on the embayment but the general ranges are illustrated in Figure II-48. Outside of estuaries, salinity probably has little effect on coastal neritic plankton where salinity variation is usually no more than 1-2 percent (TRIGOM, 1974).

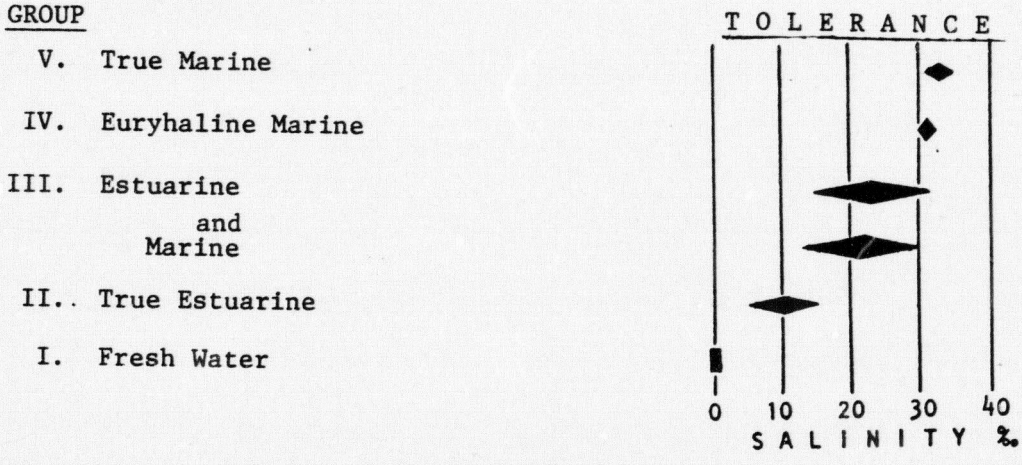

Figure II-48. Salinity Ranges for Population Maintenance (Jeffries and Alzara, 1970)

Temperature

Temperature has a complex effect on zooplankton. It affects their respiration, feeding, reproduction, size, and migrations. For example, temperature affects the reproduction and breeding of the euphausiids Meganyctiphanes and Thysanoessa spp. (Einarsson, 1945). Loosanoff, Miller, and Smith (1951) reported that the duration of the larval plankton of Mercenaria mercenaria is influenced by temperature ranges. Temperature is also important in determining the year class success of local populations of many species (TRIGOM, 1974).

Water conditions, as well as density structure, are modified by temperature. Since phytoplankton populations are affected, so are the zooplankton that are dependent on them. According to Jeffries and Johnson (1973), seasonal temperature change both in the ocean and estuaries causes a succession of species into two dominant groups: the winter-spring and summer-fall. In deeper waters, however, temperature is less variable than inshore and population fluctuations are less pronounced. Peak densities usually occur in late spring to early summer following the characteristic phytoplankton bloom (Jeffries and Johnson, 1973). In shallow waters, reductions in the standing crop can occur due to high summer temperatures (Herman et al., 1968). Each group (winter-spring and summer-fall) succeeds the other so populations are maintained year round though the temperature tolerance of each group is exceeded.

Propagation of each group is initiated by survivors of the off season or by individuals developed from eggs of the previous year (Jeffries and Johnson, 1973).

Temperature--Salinity Interaction

The major limiting factors determining the production and dispersal of estuarine zooplankton are temperature and salinity. The ranges of the two variables are much greater in estuaries than in open waters, but biological phenomena due to them are common in both habitats (Jeffries and Johnson, 1973).

Within the geographic area, Acartia clausi is usually the dominant winter-spring copepod of estuarine waters. It is replaced during the spring by A. tonsa. The elimination of A. clausi is due to temperatures exceeding its maximum for reproduction (8-12°C). A. tonsa is less sensitive to brackish water, hence, salinity is also a factor in species interaction. A. clausi is then forced seawards. Near the ocean, neither species has an advantage with respect to salinity so temperature is the chief factor causing succession (Jeffries and Johnson, 1973).

Phytoplankton--Zooplankton Relationships

Several investigations on the relationship between phytoplankton and zooplankton have been undertaken with various results.

Bigelow, Lillick, and Sears (1940) found that the grazing of zooplankton regulated phytoplankton populations. According to Riley and Bumpus (1946), seasonal cycles of diatom phytoplankton populations are correlated to seasonal fluctuations of many zooplankton species. Riley (1947) found a similar type of relationship.

Conover (1956) found that nutrient levels were more important than the grazing of zooplankton in determining phytoplankton populations during certain times of the year in Long Island Sound. The dominant species of copepods were determined by Riley (1956) to be inefficient feeders and were not a determining factor of phytoplankton populations. Other investigations (Ryther, 1954 and Deevey, 1948) revealed no phytoplankton population fluctuations as a result of zooplankton grazing.

Investigations at Narragansett Bay by Pratt (1965) and Martin (1970) revealed that relaxation of grazing pressure may initiate winter-spring flowering. The phytoplankton cycle there has also been related to nutrients (NH_3 and PO_4) regenerated by zooplankton since they excrete nitrogen and phosphorus in excess of phytoplankton requirements when their population is low (Martin, 1968).

Trophic Relationships

According to TRIGOM (1974), the relationship of specific species with their food resources is not clear. For many

species, early developmental stages may be herbivorous and later stages carnivorous. Also, diets may change as they are transported to different areas by currents. Table II-30 lists the feeding habits of some zooplankton species.

The protozoan component of the zooplankton feeds on a wide variety of foodstuffs at the base of the foodchain (e.g., bacteria, fungi, unicellular algae, other protozoa, and tissues of other organisms), and excrete nitrogen and phosphorous directly into their aquatic environments (Small, 1972).

Small copepods generally feed on the protozoa and plant material and are fed upon by most larger organisms except the algae and detrital consume shellfish. Large copepods are generally carnivorous.

Larval molluscs feed on algae while the larval oyster's food habits depend on the age of the larvae. Cirreped larval food requirements vary by species.

Feeding studies of larval fish in the coastal environs are confined to the herring (Clupea harengus). Sherman and Honey (1971) found that early larval stages feed on nauplii of copepods and decapods, and they become more opportunistic as they grow older. Other larval fishes are known to feed on phytoplankton in early stages (TRIGOM, 1974).

Tychoplankters feed primarily on detritus and benthic plant material although their efficiency may be limiting. Some forms may feed in the pelagic habitat during their upward migrations (TRIGOM,, 1974).

Stability of Zooplankton Populations

The stability of zooplankton populations can depend on factors other than those already described. According to Harvey

Table II- 30. Feeding Types of Some Zooplankton Species (TRIGOM, 1974)

Species	Herbivorous	Carnivorous	Omnivorous
Acartia clausi	xx		x
A. tonsa	xx		x
Calanus finmarchicus	xx		x
Centropages hamatus		xx	
C. typicus		xx	
Pseudocalanus minutus	xx		
Temora longicornis	xx		x
Labidocera aestiva		xx	
Tortanus discaudatus		xx	
Sagitta elegans		xx	
Oithona brevicornis	xx		
O. similis	xx		

xx = Main food type

x = Secondary but often necessary food sources

(1950), the availability of food is the most important factor. Nelson (1925), Bishop (1968), Herman et al. (1968), and Phillips et al. (1969), concluded that, to a great extent, ctenophores regulate zooplankton populations. Protozoan infestations can also affect zooplankton populations (Herman and Mihursky, 1964).

Jeffries and Johnson (1973) report that zooplankton populations appear to be able to withstand high levels of pollution. In Raritan Bay where huge amounts of waste from heavy industry, sewage plants, and petroleum refineries are introduced, they report that population levels of Acartia and Eurytemora are consistent with unpolluted estuaries nearby. The meroplankton population level there, however, indicates that they may be directly affected by the high concentration of pollutants (Jeffries and Johnson, 1973). They also report that dissolved oxygen levels affect holoplankton populations.

Distribution and Abundance

Jeffries and Johnson (1973) summarized major species of holoplankton (Table II-31). In addition, Jeffries and Johnson (1973) and TRIGOM (1974) summarized several investigations into tables, some of which are included (Tables II-32 to II-38). Jeffries and Johnson (1973), however, caution that comparisons of various investigations on zooplankton abundance and distribution must be related to sampling methods used as net size, mesh size, and duration and type of tow. For example, they state that developmental stages are lost many times due to investigators using too coarse a mesh size. Preliminary analyses of current research off the coast of New Jersey (Grant, 1976), lists dominant and subdominant organisms in the plankton (Table II-39).

Table II-31. Distribution of Major Holoplanktonic Species

(Organisms are defined in terms of salinity using the classification system of Jeffries (1967))

Species	Class
DOMINANT:	
Acartia clausi	Winter-spring; estuarine and marine
A. tonsa	Summer-fall; estuarine and marine
Calanus finmarchicus	Year round; stenohaline marine
Centropages hamatus	Year round; euryhaline marine
C. typicus	Summer-fall; stenohaline marine
Pseudocalanus minutus	Winter-spring; euryhaline marine
COMMON:	
Labidocera aestiva	Summer-fall; euryhaline marine
Tortanus discaudatus	Spring-summer; estuarine and marine
Sagitta elegans	Winter-spring; stenohaline marine
FREQUENT:	
Oithona brevicornis	Summer-fall; estuarine and marine
O. similis	Year round; euryhaline marine

(Adapted from Jeffries and Johnson, 1973)

Table II-32. Dominance Orders of Zooplankton on the Continental Shelf South of Cape Cod, Rhode Island Sound, and Narragansett Bay, Averages by Season (TRIGOM, 1974)

Species	Percentage (tr = trace)
WINTER	
Acartia clausi	10-75
Pseudocalanus minutus	8-30
Balanus balanoides	4- 7
A. tonsa	tr-40
Temora longicornis	tr- 3
Tortanus discaudatus	tr- 3
Gastropod eggs and larvae	tr- 4
SPRING	
Acartia clausi	
Pseudocalanus minutus	9-25
Evadne nordmanni	3-17
Acartia tonsa	tr-40
Centropages hamatus	tr- 9
Gastropod eggs and larvae	tr- 6
Tortanus discaudatus	tr- 4
Podon polyphemoides	tr- 4
Temora longicornis	tr- 3
Fish eggs	tr- 2
SUMMER	
Acartia tonsa	10-87
A. clausi	tr-20
Centropages hamatus	tr-24
Evadne nordmanni	3- 9
Pseudocalanus minutus	1- 3
Podon polyphemoides	tr-12
Decapod larvae	tr- 7
Tortanus discaudatus	tr- 6.7
Temora longicornis	tr- 6
Gastropod larvae	tr- 5
FALL	
Acartia tonsa	24-82
A. clausi	2-29
Podon polyphemoides	tr- 7
Pseudocalanus sp.	tr- 2
Oithona sp.	tr- 4
Temora longicornis	tr- 1
Podon intermedius	tr- 1

Table II-33 Dominance Orders of Zooplankton in Block Island Sound (TRIGOM, 1974)

Species	Percentage (tr = trace)
WINTER	
Pseudocalanus minutus	10-70
Centropages typicus	tr-25
Oithona similis	tr-25
Acartia tonsa	tr-15
Centropages hamatus	tr- 6
Sagitta elegans	tr- 3
Balanus larvae	tr- 5
Paracalanus crassirostris	tr-10
Evadne spp.	tr-10
Tortanus discaudatus	tr- 7
SPRING	
Pseudocalanus minutus	6-42
Centropages hamatus	tr-24
Temora longicornis	1.5-11
Oithona similis	tr-12
Evadne spp.	tr-11
Acartia clausi	tr- 9
Centropages typicus	tr- 7
Calanus finmarchicus	tr-21
Fritillaria sp.	tr-15
Hydromedusae	tr- 8
SUMMER	
Acartia tonsa	tr-50
Centropages typicus	2-30
C. hamatus	2-23
Temora longicornis	tr- 8
Pseudocalanus minutus	tr- 8
Podon intermedius	tr- 7
Oikopleura spp.	tr- 9
Doliolum spp.	tr-14
Evadne spp.	tr-11
Penilia sp.	tr- 6
FALL	
Centropages typicus	1-34
Acartia tonsa	tr-58
Penilia sp.	tr-19
Podon intermedius	tr-23
Pseudocalanus minutus	tr-27
Doliolum sp.	tr- 5
Oikopleura sp.	tr- 3
Paracalanus spp.	tr-10
Oithona similis	tr-24
Evadne spp.	tr-13

Table II- 34. Dominance Order of Zooplankton in Raritan Bay, New York Bight, and Sandy Hook Bay (TRICOM, 1974)

Species	Percentage
WINTER	
Harpacticoids	16
Acartia tonsa	10
Eurytemora affinis	8
Acartia clausi	6
Pseudodiaptomus coronatus	3
SPRING	
Harpacticoids	18
Eurytemora affinis	12
Cladocera	7
Acartia clausi	6
Paracalanus crassirostris	1
SUMMER	
Acartia tonsa	49
Cladocera	7
Paracalanus crassirostris	2
Acartia clausi	1
FALL	
Acartia tonsa	36
Harpacticoids	3
Pseudocalanus crassirostris	3
Eurytemora affinis	1
Paracalanus crassirostris	1

Table II-35. Dominance Order of Zooplankton in Sandy Hook Bay Average Over a Year (Sage and Herman, 1972 and TRIGOM, 1974)

Species	Average #/m^3	Percent	Rank
Acartia tonsa	4224	30.5	1
Copepodites	3543	25.6	2
Eurytemora affinis	1396	10.1	3
Podon polyphemoides	747	5.4	4
Tachidius littoralis	738	5.3	5
Nauplii	582	4.2	6
Littorina capsules	535	3.9	7
Evadne nordmanni	278	2.0	8
Pseudodiaptomus coronatus	232	1.7	9
Gastropoda	221	1.6	10
Acartia clausii	212	1.5	11
Paracalanus crassirostris	211	1.5	12
Pseudocalanus minutus	133	1.0	13
Oithona similis	114	0.8	14
Tisbe furcata	105	0.8	15
Polychaeta	98	0.7	16
Podon leuckarti	90	0.6	17
Eurythemora americana	69	0.5	18
Temora longicornis	58	0.4	19
Tortanus discaudatus	39	0.3	20
Labidocera aestiva	37	0.3	21
Zoea sp.	35	0.3	22
Crangon septemspinosus	31	0.2	23
Eurytemora herdmani	18	0.1	24
Centropages typicus	18	0.1	24
Penilia avirostris	15	0.1	25

Table II-36. Dominance Order of Zooplankton in Sandy Hook Bay for May-June, 1962 (Yamazi, 1966 and TRIGOM, 1974)

Species	Percent of Total Zooplankton
Synchaeta littoralis	18-72
Copepod nauplii	10-32
Benthic larvae	3-39
Acartia clausi	7-25
Pseudodioptomus coronatus	1- 7

Table II-37. Standing Crop of Zooplankton in Raritan Bay and the New York Bight (Jeffries and Johnson, 1973)

I. Jeffries (1964)
II. National Marine Fisheries Service (1972)

Month	I. Raritan Bay Mesh #12 Unit #/m^3	II. New York Bight Mesh #8 Unit $\mu\ell/m^3$
January	--	309
February	--	307
March	1,000	454
April	3,000	633
May	70,000	783
June	110,000	883
July	50,000	725
August	55,000	917
September	100,000	802
October	--	775
November	--	747
December	--	217

Table II-38. Maximum Standing Crop of Zooplankton for Sandy Hook Bay (Sage and Herman, 1972 and TRIGOM, 1974)

Month	cc/m^3	$\#/m^3$
January	0.6	1,000
February	0.9	1,000
March	0.8	1,500
April	1.4	6,000
May	4.2	52,000
June	3.0	14,000
July	3.1	14,000
August	5.4	28,000
September	2.9	17,000
October	2.9	13,000
November	0.7	3,000
December	0.7	1,000

Table II-39. Dominance in Plankton Off the New Jersey Coast (adapted from VIMS, 1976)

Approximate Mileage from New Jersey Coast	Organisms of: Primary Dominance	Secondary Dominance	Subdominance
20	Copepods *Labidocera aestiva* *Pontella meadii* *Centropages typicus* *Acartia tonsa*	Fish eggs	Decapod larvae Fish larvae Amphipods Mysids Chaetognaths *Beroe ovata* Isopods (Idotea metallica) Cladocerans (*Penilia avirostris*)
60	Copepods *Centropages typicus* *Calanus finmarchicus* *Anomalocera patersonii* *Paracalanus* sp.	Hyperiids Isopods (*Idotea metallica*)	Decapod larvae Fish larvae Fish eggs Chaetognaths Molluscs
95	Copepods *Anomalocera patersonii* *Centropages typicus* *Calanus finmarchicus* *Calanus minor*	Copepods (*Paracalanus* sp.) Chaetognaths *Sagitta tasmanica* *Sagitta elegans* Hyperiids Fish eggs Medusa	Isopods (*Idotea metallica* Chaetognaths Molluscs Decapod larvae Fish larvae Siphonophores Hyperiids Euphausiids

The zooplankton of Cheseapeake Bay include the copepods (frequently measuring half the zooplankton population excluding large medusae and ctenophores), astracods, cladocerans, amphipods, meroplanktonic larvae of barnacles, decapods, molluscs and annnelids, chaetognaths, fish eggs and larvae. In addition the zooplankton including large numbers of protozoa including ciliaphora, amoeboid sarcondinids, formaminifera, sporozoa and phytoflagellates.

A single cubic meter of Chesapeake Bay water may contain over three million copepods, or planktonic crustaceans (Lippson, 1973). While there are about 30 species of copepods in the Chesapeake Bay, five species make up about 95% of the Chesapeake Bay biomass of copepods. In decreasing order of importance they are Acartia tonsa, Eurytemora affinis, Scoffolans canadensis, Acartia chansi, and Oithona brenicornia (Lippson, 1973). Species of copepods may be distributed according to salinity gradients and may inhabit different depths of the Bay during their life cycle, frequently coming near the surface while young.

c. Benthos

Flora

The distribution of benthic marine algae along the New York, New Jersey, Delaware, Maryland, and Virginia coast is not very well documented.

Zaneveld and Barnes (1965) report sandy and muddy substrates for the coastline at the mouth of the Chesapeake Bay which are barren of macroscopic algae. They report distribution of species on a seasonal basis for the area (Table II-40). Zaneveld (1966) described the Cyanophyta from Cape May, New Jersey, to Cape Hatteras, North Carolina (Table II-41) and the marine algae off Delaware (Zaneveld, 1966b). Wulff et al. (1968) surveyed species off Ocean City, Maryland. The distribution of benthic algae of coastal Maryland, however, is probably the least known of areas of the Atlantic coastline (Halvorson and Dawson, 1973).

The substrate of the Delaware Coast is primarily sand with mixed sand and mud dominating Delaware Bay. Both substrates are inhospitable for benthic algae as compared to rocky shores (Zaneveld, 1972). Zaneveld (1972) reported 74 species of marine algae (69 were benthic) for the east coast of Delaware and the lower Delaware Bay (Halvorson and Dawson, 1973). They are seasonal in character as none of them were found to occur year round (Table II-42 .

Richards (1932) lists 61 species off of New Jersey. In the same study, he describes previous investigations on the algae of New Jersey and

Table II-40. The Seasonal Presence of the Vegetative Thalli of 29 Benthic Marine Algae in Lower Chesapeake Bay (Zaneveld and Barnes, 1965; Halvorson and Dawson, 1973)

Species	Winter Flora	Spring Flora	Summer Flora	Autumn Flora	Perennial Flora
Chlorophyta					
Enteromorpha minima	+		+		*Enteromorpha intestinalis*
Cladophora gracilis	+		+		*E. linza*
Bryopsis hypnoides			+		*Ulva lactuca*
Phaeophyta					*Cladophora flexuosa*
Punctaria plantaginea		+	+	+	*Bryopsis plumosa*
Petalonia fascia	+	+	+		
Scytosiphon lomentaria	+	+	+		*Gracilaria verrucosa*
Rhodophyta					*Agardhiella tenera*
Bangia fuscopurpurea	+	+	+		*Callithamnion byssoides*
Porphyra leucosticta	+				*Ceramium rubrum*
P. umbilicalis	+	+	+		*Grinnellia americana*
Gracilaria foliifera	+			+	*Polysiphonia nigrescens*
Dasya pedicellata	+	+	+		
Polysiphonia harveyi	+		+		
Gelidium crinale			+		
Champia parvula			+	+	
Ceramium fastigiatum			+		
C. strictum			+		
C. diaphanum			+		
Polysiphonia denudata			+	+	

Table II-41 Distribution of the Delaware Benthic Marine Algae Along the East Coast of North America (Modified from Zaneveld, 1972; Halvorson and Dawson, 1973)

(+) plants present (-) no record (*) washed ashore

Species	LOCALITY Between Cape May, N.J., and Cape Hatteras, N.C.	North of Cape May	South of Cape Hatteras
Cyanophyta			
Entophysalis deusta	May Del.Md.Va.	+	+
Calothrix crustacea	Del.Md.Va.N.C.	+	+
Spirulina subsalsa	Del.Va.	+	+
Schizothrix calcicola	Del.Md.Va.N.C.	+	+
Porphyrosiphon splendidus	Del.Va.	+	-
Oscillatoria princeps	Del.Va.	+	+
Oscillatoria laetevirens	Del.Va.	+	-
Microcoleus chtonoplastes	Del.Md.Va.N.C.	+	+
Lyngbya confervoides	May Del.Md.N.C.	+	+
Lyngbya aestuarii	Del.Md.Va.N.C.	+	-
Lyngbya semiplena	Del.Md.Va.N.C.	+	+
Chlorophyta			
Ulothrix flacca	Del.	+	+
Pilinia rimosa	Del.	+	-
Percursaria percursa	Del.Md.Va.	+	-
Blidingia minima	Del.Va.	+	+
Enteromorpha marginata	Del.Va.	+	-
Enteromorpha prolifera	May Del.Md.Va.N.C.	+	+
Enteromorpha intestinalis	May Del.Md.Va.N.C.	+	+
Enteromorpha linza	May Del.Md.Va.N.C.	+	+
Ulva lactuca var. latissima	May Del.Md.Va.N.C.	+	+
Ulva lactuca var. rigida	Del.Va.N.C.	+	+
Urospora penicilliformis	Del	+	-
Urospora collabens	Del.	+	-
Chaetomorpha aerea	D	+	+
Rhizoclonium kerneri	D	+	-
Rhizoclonium riparium	De	+	+
Cladophora albida	Del.Va.	+	+
Cladophora crystallina	Del.Va.N.C.	+	+

Table II-41. Continued.

Species	Between Cape May, N.J., and Cape Hatteras, N.C.	LOCALITY North of Cape May	South of Cape Hatteras
Chlorophyta (Continued)			
Cladophora flexuosa f. *densa*	Del.Va.	+	+
Cladophora expansa	Del.Va.	+	-
Bryopsis hypnoides	Del.Md.Va.	+	+
Bryopsis plumosa	May Del.Md.Va.	+	+
Vaucheria piloboloides	Del.Va.	+	-
Phaeophyta			
Pylaiella littoralis	May Del.Md.Va.	+	-
Ectocarpus confervoides	Del.Md.Va.N.C.	+	+
Ectocarpus fasciculatus	May Del.	+	-
Ectocarpus tomentosus	Del.	+	-
Sorcarpus micromorus	Del.	+	-
Ralfsia verrucosa	Del.	+	-
Elachista fucicola	Del.	+	-
Leathesia difformis	Del.Va.N.C.	+	+
Punctaria plantaginea	Del.Md.	+	-
Petalonia fascia	Del.Md.Va.	+	+
Scytosiphon lomentaria	May Del.Md.Va.	+	+
Ascophyllum nodosum	Del.Md.Va.	+	+*
Fucus edentatus	Del.Md.Va.	+	-
Fucus spiralis	Del.Md.Va.	+	-
Fucus vesiculosus	Del.Md.Va.N.C.	+	+*
Fucus vesiculosus var. *laterifructus*	May Del.Md.Va.	+	-
Fucus vesiculosus var. *sphaerocarpus*	Del.Md.Va.	+	-
Fucus vesiculosus var. *spiralis*	Del.	+	-
Sargassum hystrix var. *buxifolium*	Del.*Va.*N.C.*	+*	+
Sargassum natans	Del.*Md.*Va.*N.C.*	+*	+

Table II-41. Continued.

Species	LOCALITY: Between Cape May, N.J., and Cape Hatteras, N.C.	North of Cape May	South of Cape Hatteras
Rhodophyta			
Bangia fuscopurpurea	Del.Md.Va.	+	+
Porphyra umbilicalis	May Del.Md.Va.	+	+
Agardhiella tenera	May Del.Md.Va.N.C.	+	+
Hypnea musciformis	Del.*Md.*Va.*	+	+
Gracilaria verrucosa	May Del.Md.Va.N.C.	+	+
Gracilaria foliifera	May*Del.*Md.*Va.*N.C.	+	+
Phyllophora membranifolia	Del.	+	-
Chondrus crispus	Del.Va.	+	-
Callithamnion baileyi	May Del.Md.Va.	+	-
Spermothamnion turneri var. variabile	Del.N.C.	+	+
Pleonosporium borreri	May Del.	+	+
Ceramium fastigiatum	May Del.Md.Va.	+	+
Ceramium strictum	May Del.Md.Va.N.C.	+	+
Ceramium diaphanum	Del.Md.*Va.	+	-
Ceramium rubrum	May Del.Md.Va.	+	+
Chondria tenuissima	Del.Md.Va.	+	+
Polysiphonia harveyi	Del.Md.Va.N.C.	+	+
Polysiphonia fibrillosa	Del.*	+	-
Polysiphonia subtillissima	May Del.Md.Va.N.C.	+	+
Polysiphonia denudata	May Del.Md.Va.N.C.*	+	+
Polysiphonia nigrescens	Del.Md.Va.N.C.*	+	+

Table II-42. Seasonal Occurrence of the Marine Benthic Algae of Delaware Between Cape May, New Jersey, and Cape Hatteras, North Carolina (Zaneveld, 1972; Halvorson and Dawson, 1973)

(+) vegetative plants
(-) plants absent
(a) antheridia
(g) gametangia
(o) oogonia
(s) swarmers
(#) small spores
(##) large spores
(c) cystocarps
(m) monospores
(t) tetraspores
(p) plurolocular sporangia
(r) receptacles
(u) unilocular sporangia

Species	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Cyanophyta												
Entophysalis deusta	-	-	-	+	-	+	+	+	-	-	-	-
Calothrix crustacea	-	+	-	-	-	+	+	+	-	-	-	-
Spirulina subsalsa	-	-	-	-	-	+	-	+	-	-	-	-
Porphyrosiphon splendidus	-	-	-	-	-	+	-	-	+	-	-	-
Oscillatoria princeps	-	-	-	-	-	+	-	+	-	-	-	-
O. laetevirens	-	-	-	-	-	+	+	-	-	-	-	-
Lyngbya confervoides	-	-	-	-	-	+	+	+	-	-	-	-
L. aestuarii	-	-	-	-	-	+	+	-	-	-	-	-
L. semiplena	-	+	-	-	-	+	+	+	+	-	+	-
Chlorophyta												
Ulothrix flacca	-	-	-	+	-	-	-	-	-	-	+	-
Pilinia rimosa	-	-	-	-	-	+	-	-	-	-	-	-
Percursaria percursa	-	-	-	-	-	+	-	-	-	-	-	-
Blidingia minima	+	+	-	+	-	s	s	-	-	-	+	-
Enteromorpha marginata	-	-	-	-	-	+	-	-	-	-	-	-
E. prolifera	-	-	-	+	+	s	s	-	-	-	-	-
E. intestinalis	+	+	+	+	s	s	s	s	s	s	s	-
E. linza	+	+	-	-	s	s	s	s	-	-	s	-
Ulva lactuca var. latissima	-	+	-	-	s	s	s	s	s	-	s	-
U. lactuca var. rigida	-	-	-	+	-	s	-	-	s	-	-	-
Urospora penicilliformis	-	-	-	+	-	-	-	-	-	-	-	-

Table II-42. Continued.

Species	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Chlorophyta (Continued)												
Urospora collabens	-	-	-	+	-	-	-	-	-	-	-	-
Chaetomorpha aerea	-	-	-	-	-	s	s	-	-	-	-	
Rhizoclonium kerneri	-	-	-	-	-	+	-	-	-	-	-	-
R. riparium	-	-	-	-	-	-	-	-	+	-	-	-
Cladophora albida	-	-	-	-	+	-	s	s	-	-	+	-
C. crystallina	-	-	-	-	-	+	+	-	-	-	-	-
C. flexuosa f. densa	-	-	-	-	s	s	s	s	s	s	-	-
C. expansa	-	-	-	-	-	+	-	-	-	-	-	-
Bryopsis hypnoides	-	-	-	+	-	g	-	-	-	-	-	-
B. plumosa	-	+	-	+	g	g	g	-	-	-	+	-
Vaucheria piloboloides	+	-	-	-	-	a,o	-	-	-	-	-	-
Phaeophyta												
Pylaiella littoralis	u	-	u	-	-	p	p	-	-	-	u	-
Ectocarpus confervoides	+	-	-	u	u,p	p	p	-	-	p	-	-
E. fasciculatus	-	-	-	-	-	p	-	-	-	-	-	-
E. tomentosus	-	-	-	-	-	+	-	-	-	-	-	-
Sorocarpus micromorus	-	-	-	+	-	-	-	-	-	-	-	-
Ralfsia verrucosa	-	-	-	-	-	+	-	-	-	-	-	-
Elachista fuciocola	-	-	-	-	-	+	-	u	-	-	-	-
Leathesia difformis	-	-	-	-	+	-	-	-	-	-	-	-
Punctaria plantaginea	-	-	-	u	-	u,p	u,p	-	-	-	-	-
Petalonia fascia	-	-	-	-	-	p	p	-	-	-	-	-
Scytosiphon lomentaria	-	-	-	p	-	p	p	-	-	-	-	-
Ascophyllum nodosum	-	-	-	-	-	r	r	r	r	r	r	-
Fucus edentatus	-	-	-	-	-	-	+	-	-	-	-	-
Fucus spiralis	-	-	-	-	-	-	-	+	-	-	-	-
F. vesiculosus	-	r	r	r	r	r	r	r	r	r	r	-
F. vesiculosus var. laterifructus	-	-	-	-	-	r	r	r	-	-	-	-
F. vesiculosus var. sphaerocarpus	-	-	-	-	-	r	-	-	-	-	-	-
F. vesiculosus var. spiralis	-	-	-	-	-	r	-	-	-	-	-	-

Table II-42. Continued.

Species	Month											
Phaeophyta (Continued)	J	F	M	A	M	J	J	A	S	O	N	D
Sargassum hystrix var. *buxifolium*	-	-	-	-	+	-	+	+	+	+	-	-
S. natans	-	-	-	-	-	-	+	+	-	-	+	-
Rhodophyta												
Bangia fuscopurpurea	-	m	-	m	-	+	+	-	-	-	-	m
Porphyra umbilicalis	#	#,##	-	#,##	-	#,##	-	-	-	#,##	-	#
Agardhiella tenera	+	+	a	a	-	c,t	c,t	c,t	c,t	c,t	-	-
Hypnea musciformis	-	-	-	-	-	-	c,t	c,t	-	-	-	-
Gracilaria verrucosa	+	+	+	c	c,t	c,t	c,t	c,t	-	c	-	-
G. foliifera	-	-	-	-	-	-	-	c,t	-	-	-	-
Phyllophora membranifolia	-	-	-	c,t	-	-	-	-	-	-	-	-
Chondrus crispus	-	-	-	-	-	c,t	c,t	-	-	-	-	-
Callithamnion baileyi	-	-	-	-	-	c,t	c,t,	-	-	-	-	-
Spermothanion turneri var. *variabile*	-	-	-	-	-	-	-	+	-	-	-	-
Pleonosporium borreri	-	-	-	a	-	-	-	-	-	-	-	-
Ceramium fastigiatum	-	-	-	-	-	c,t	c,t	c,t	-	-	-	-
C. strictum	-	-	-	c,t	-	c,t	c,t	c,t	-	-	c,t	-
C. diaphanum	-	-	-	-	-	-	c,t	-	-	-	-	-
C. rubrum	a,c t	a,c t	a,c t	c,t	c,t	c,t	c,t	c,t	c,t	-	c,t	-
Chondria tenuissima	-	-	-	-	-	c,t	c,t	c,t	-	-	-	-
Polysiphonia harveyi	-	-	+	-	c,t	c,t	c,t	c,t	-	-	c,t	-
P. fibrillosa	-	-	-	-	-	-	-	-	-	-	+	-
P. subtillissima	-	-	-	-	-	-	t	-	-	-	-	-
P. denudata	-	-	-	-	c,t	c,t	c,t	c,t	c,t	-	+	-
P. nigrescens	-	a,c	-	-	c,t	c,t	c,t	-	-	-	-	-

notes that these identified more species. He felt that the decrease was due to inadequate collecting, various forms of pollution, and land alterations (Halvorson and Dawson, 1973). In a later study, Moeller (1964) also lists fewer species for Barnegat Bay (Table II-43.

Conard (1935) describes the benthic marine algae of Great South Bay and the Atlantic coast off Long Island (Table II-44). The species occurring there are remnants of forms common to more northern areas (Halvorson and Dawson, 1973). Johnson and York (1915) also described the marine algae in the area. They divided them into three categories, those growing in loose soil, those growing in more settled substrates (20 species), and epiphytic algae (8 species).

Algae of the Chesapeake Bay include the Cyanophycophyta, Chlorophyta, Phaeophyta, and Rhodophyta (Krauss, 1972). There are approximately 213 taxa of benthic and pelagic macroalgae of the Chesapeake Bay and the Atlantic coasts of Virginia and Maryland. These are distributed into four algal divisions as follows:

	Taxa	Percent
Chlorophycophyta	55	25.8
Phaeophycophyta	29	13.6
Rhodophycophyta	54	25.4
Cyanophycophyta	75	35.2

(Ott, 1972)

However, little is known on the effects of light quantity and quality temperature, pH, salinity, organic and inorganic nutrients, and the effects of wave action on this area's macroalgae (Ott, 1972). The seasonal presence of the vegetative thalli of 29 benthic marine algae in lower Chesapeake Bay are found in Table II-40 .

Table II-43. Algae of Barnegat Bay (Modified from Moeller, 1964; Halvorson and Dawson, 1973)

Chlorophyta

1. Ulothrix implexa
2. Rhizoclonium riparium
3. Enteromorpha prolifera
4. E. linza
5. E. intestinalis
6. Cladophora gracilis
7. Ulva lactuca

Rhodophyta

8. Gracilaria verrucosa
9. G. foliifera
10. Agardhiella tenera
11. Dasya pedicellata
12. Polysiphonia subtilissima
13. Spyridia filamentosa
14. Champia parvula
15. Callithamnion sp.
16. Polysiphonia flexicaulis
17. Ceramium sp.
18. C. fastigiatum
19. Chondria baileyana

Table II-44. Distribution of Marine Algae Off New York (Modified from Conard, 1935; Halvorson and Dawson, 1973)

Tidal Level Below mean Low Water (MLW)	Species	Location
2 m	Laminaria agardhii	Eaton's Point, Montauk Point
	L. idigitata	Montauk Point
	Rhodymenia palmata	Montauk Point
	Chorda filum	Montauk Point
30 cm - 1 m	Chondrus crispus	Eaton's Point, Montauk Point
	Ceramium rubrum	Eaton's Point, Montauk Point
	Porphyra umbilicalis	Eaton's Point, Montauk Point, Center Island
	Ulva lactuca	Eaton's Point, Montauk Point, Center Island
	Champia parvula	Montauk Point
15 cm	Ahnfeltia plicata	Eaton's Rock
	Dasya pedicellata	Center Island
	Grinnellia americana	Center Island
	Ceramium strictum	Center Island
	Callithamnion sp.	Center Island
	Lomentaria uncinata	Center Island
	Champia parvula	Center Island
Tidal Stream	Polysiphonia variegata	Center Island
	Bryopsis plumosa	Center Island
	Gracilaria multipartita	Center Island

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Fauna

Introduction

The sea floor in the area consists primarily of level bottoms with unconsolidated sediment. The majority of animals inhabitating the area are infaunal species which occupy burrows, tubes, or move through the sediment. A smaller percentage of epifaunal species move over the sediment surface (Pratt, 1973). The benthic invertebrate population is represented by 20 of the 22 phyla in the animal kingdom (TRIGOM, 1974). Many benthic invertebrates are of commercial value and will be further discussed in section II.G.1.f. Wigley and McIntyre (1964), calculated the macrobenthos, which are the larger and conspicuous organisms (as opposed to meiobenthos), account for approximately 96 percent of the biomass in bottom sediments.

There are basically four feeding categories characteristic of the benthic fauna: deposit feeders, suspension feeders, herbivores, and predators. Deposit feeders (selective or non-selective) feed on organic matter off the bottom; suspension feeders feed on organic matter in the water column; herbivores feed on plant materials; and predators feed on other animals.

In a preliminary report of a study conducted off of southern New Jersey, Boesch (1976)[1] states that submersible observation and bottom photographs indicate a very high density of asteroids, Asterias forbesi and A. vulgaris, on the inner and mid-shelf, and Astropecten americanus on the outer shelf. The crabs, Cancer irroratus and Cancer borealis, are abundant over the inner and mid-shelf as are several hermit crab species, notably Pagurus acadianus. On the outer shelf in the southern portion of the area studied, a motile tubuolus polychaete, Onuphis (Nothria) conchylega, is particularly dense and may also exert predatory influence on infauna, as may the galatheid "lobster" Munida iris which was also common on the outer shelf.

Boesch (1976)[1] also notes that the samples taken in the study area have produced specimens of several uncommon or unusual organisms. One specimen of the cephalocarid crustacean Hutchinsoniella macracantha has been found. Only seven species of this primitive group of crustaceans are known and only 6 other specimens of Hutchinsoniella are known from the Atlantic shelf. Another unusual crustacean, an unidentified nebaliacean, was also found. A dominant organism at several sites on the outer shelf (deeper than 100m) was a branched zoantharian anemone, Isozoanthus sp., apparently undescribed and unknown from the western North Atlantic.

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[1]BLM baseline studies, under contract by Virginia Institute of Marine Sciences.

Continental Shelf Fauna

Three level bottom faunal groups are tentatively identified for the Mid-Atlantic Continental Shelf. They are the sand, silty sand, and silt-clay faunas. They are categorized using Wigley's (1968) description for the Gulf of Maine region and are identified on the basis of sediment type and the presence of certain species. Pratt (1973) points out, however, that further investigations are necessary before these groups can be identified as to the extent they are separate entities or as having characteristic species. He states that it is too early to name the faunal groups of the Mid-Atlantic Bight. Figure II-49, however, illustrates general distribution of the faunal types that relate to sediment type distributions. Visual 3 shows bottom sediment types.

Sand Fauna

The sand fauna is associated with clean sands. This habitat merges with the sandy beach inshore and extends to depths of from a few meters to 30-50 meters (Pratt, 1973). In the area, this habitat is characteristic of the open coast from Long Island to Cape Hatteras. The sand substrate is very mobile, and animals living in this habitat are adapted to sediment mobility. Suspended food is abundant in these areas, and water and sediment oxygen levels are characteristically high (Pratt, 1973).

Pratt (1973) lists the following species reported by Wigley (1968) with some additions, as distributed throughout the region and important in the Mid-Atlantic area:

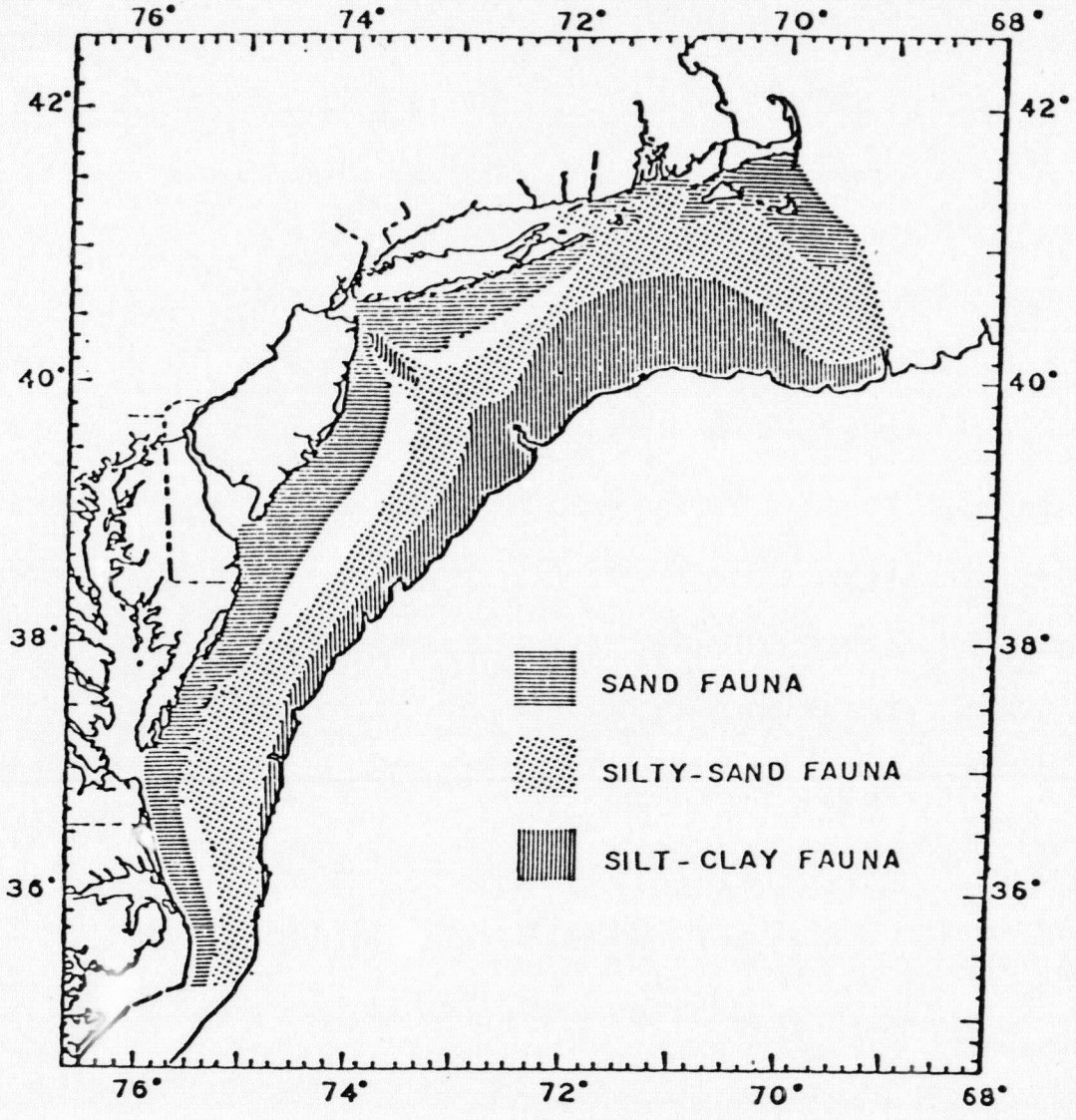

Figure II-49. Continental Shelf faunal types in the Mid-Atlantic Bight showing general areas occupied by proposed faunal types. The boundary between the sandy and silty sand fauna is hard to define at this time (Pratt, 1973).

Polychaetes: (worms) Scolopus fragilis, Nephtys bucera, N. picta, Nereis arenaceodonta, Sthenelais limicola, Spiophanes bombyx, Ophelia sp., Goniadella sp., Clymenella sp., Aricidea sp., and Magelona sp., (deposit (feeders).

Bivalves: (clams) Spisula solidissima, Astarte castanea, Ensis directus (suspension feeders), Tellina agilis (deposit feeder).

Gastropods: Polinices duplicatus and Lunatia heros (predators).

Amphipods: haustorids (suspension feeders), phoxacephalids and lysianassids (deposit feeders and scavengers).

Decapods: (crabs) Crangon septemspinosus and Cancer irroratus (omnivore and scavenger).

Echinoderm: (sand dollars) Echinarachnius parma (deposit feeder).

Ascidians: (sea squirts) Amaroucium and Mogula arenata (suspension feeders).

Anthozoa: Paranthus rapiformis (suspension feeder).

Watling and Maurer (1974) also derived a list of species thought to be characteristic of the near-shore fauna by summarizing the studies of Pettibone, 1963; Hall, 1964; Williams, 1965; Gray et al., 1968; Pearce, 1972; Bousfield, 1973; Day, 1973; Menzies et al., 1973; Steimle and Stone, 1973.

Phylum Annelida (segmental worms)

Class Archiannelida
Polygordius sp.

Class Polychaeta

Family Cirratulidae
Caulleriella sp.
Tharyx sp.

Family Glyceridae
Glycera capitata
Glycera dibranchiata

Family Goniadidae
Goniadella gracilis

Family Lumbrinereidae
Lumbrinereis acuta
Lumbrinereis fragilis

Family Magelonidae
Magelona sp.

Family Maldanidae
Clymenella torquata
Clymenella zonalis

Family Nephtyidae
Nephtys bucera
Nephtys circinata
Nephtys picta

Family Paronidae
Aricidea cerruti (*jeffreysii*)

Family Phyllodocidae
Eteone lactea
Eteone heteropoda

Family Spionidae
Spiophanes bombyx

Family Syllidae
Exogone hebes
Exogone verugera
Parapionosyllis longicirrata
Streptosyllis arenae

Phylum Mollusca (Bivalves and snails)

Class Gastropoda

Family Trochidae
Margarites groenlandicus

Class Gastropoda (Continued)

Family Naticidae
Lunatia heros
Polinices duplicatus

Family Buccinidae
Colus pygmaea

Family Nassariidae
Nassarius trivittatus

Class Pelecypoda

Family Arcticidae
Artica islandica

Family Cardiidae
Cerastroderma pinnulatum

Family Mactridae
Spisula solidissima

Family Solenidae
Ensis directus

Phylum Arthropoda (crabs, shrimp, amphipods, isopods)

Class Crustacea

Order Cumacea

Family Leuconidae
Leptocuma minor
Eudorellopsis deformis

Order Tanaidacea

Family Tanaidae
Tanaissus lilljeborgi

Order Isopoda

Family Anthuridae
Ptilanthura tricarina

Family Cirolanidae
Cirolana concharum
Cirolana polita

Family Idoteidae
Chiridotea arenicola

Order Amphipoda

Family Ampeliscidae
Ampelisca aequicornis
Byblis serrata

Family Corophiidae
Pseudunciola obliquua
Siphonoecetes smithianus
Unciola dissimilis
Unicola irrorata

Family Haustoriidae
Protohaustorius deichmannae
Protohaustorius wigleyi

Family Phoxocephalidae
Phoxocephalus holbolli
Trichophoxus epistomus

Order Decapoda

Family Cancridae
Cancer irroratus

Phylum Echinodermata (starfish, sand dollars, sea urchins)

Class Echinoidea
Echinarachnius parma

Class Asteroides
Asterias vulgaris

According to Boesch (1972), Pratt (1973) found that, with few exceptions, the sand fauna off the coast of Virginia is the same as the sand fauna off southern New England. It may be that a single sand community exists throughout the area (Pratt, 1973).

Little is known of the productivity of the sand fauna in the area (Pratt, 1973). Lee (1944) reported for Martha's Vineyard that sandy areas have lower fish food biomass than silty-sand areas.

Silty-sand Fauna

According to Pratt (1973), sediment differences between those supporting a silty-sand fauna and sand fauna can be small. Most often they are areas where 25 percent of the sand substrate is silt or where the sand substrate has a higher organic content, usually with an organic covering over the sediment (Figure II-49). The fauna of this zone is different from the mobile, inner sand areas and includes suspension and deposit feeders which occupy tubes and burrows (Pratt, 1973). Sediment stability in this area allows for vertical structure as compared to mobile, sand areas.

Wigley (1968) lists some members with additions from Pratt (1973) for this area:

Polychaetes: Pherusa offinis, Clymenella torquata, Maldanopsis elongata, Scalibregma sp., Nephtys sp., and Harmothoe sp. (deposit feeders).

Bivalves:	Arctica islandica, Cardita borealis, Astarte sp. (suspension feeders).
Amphipod:	Ampelisca vadorum, A. verrilli, A. agassizi, A. macrocephala (deposit feeders), Unciola irrorata (suspension feeder).
Isopods:	Edotea montosa (deposit feeder).
Cumaceans:	(deposit feeders).
Anemone:	Cerianthus americanus (suspension feeder).
Holothuroidean:	Thyone sp. (deposit feeder).

Productivity studies for this area include those of Lee (1944), Wigley and McIntyre (1964), Wigley (1965), Pearce (1970), Wigley and Thoroux (1970), and Saila, Pratt, and Polgar (1972). They found that the sand-silt has a higher biomass than the sand fauna. Wigley (1965) reports that the fauna is highly productive in terms of fish food and often maintains year round populations.

At the present time, the boundary between sand and silty sand fauna is not defined. This is especially true for the New Jersey area where substrates are very mobile (Pratt, 1973).

Silt-Clay Fauna

Fine sediments are primarily found in estuaries, bays, and near the shelf edge (Visual 3). Exceptions are the shelf off southern New England and the Hudson Channel (Pratt, 1973).

According to Pratt (1973), characteristic species include:

Echinoderms: Briaster fragilis, Ophiura sarsi, O. robusta, Amphiura otteri, Ctenodiscus crispatus (deposit feeders).

Polychaetes: Nephtys sp., Tharyx sp., Cossura sp. (deposit feeders).

Bivalve: Nucula sp. and others.

Wigley and McIntyre (1964) reported high numbers of molluscs and polychaetes for southern New England at 69-99 meters (Pratt, 1973). Sanders, Hessler, and Hampson (1965) for the same area report a large population of polychaetes and ophiuroids followed by bivalves, coelenterates, and crustaceans.

Fish yield from this area is lower than silty-sand areas. The silt-clay fauna, however, support groundfish and lobsters (Pratt, 1973).

Submarine Canyons

Several canyons extend onto the Continental Shelf (Shepard and Dill, 1966). The canyons are most commonly covered with mobile silts.

Hudson Canyon is the largest in the area and has a shallow valley, the Hudson Channel, which extends across the shelf and into the New York Bight. Currents associated with the canyons are a medium of transport for suspended matter and often support higher benthic population than adjacent areas.

From the few benthic investigations in this area, it is clear that the fauna differs from non-canyon areas. Studies of this fauna include those of Rowe and Menzies (1969), Sanders and Hessler (1969), and Rowe (1971). They include distribution of species in bands parallel to bottom contours or concentrations in patches in certain areas.

According to Pratt (1973), distribution in canyon areas can differ due to:

(1) different hydrographic conditions due to interruption of the bottom current;

(2) presence of areas of indurated sediments;

(3) higher concentrations of suspended matter providing food for filter feeders;

(4) deposited organic matter providing food for deposit feeders.

Beaches

The coastline of the Mid-Atlantic area is primarily composed of open, sandy beaches. Environmentally, this zone presents extreme conditions in terms of availability of food, and extreme levels

of salinity, oxygen, and temperature (Pratt, 1973). There is little species diversity in this habitat but a higher number of individuals present.

Ecological descriptions of beaches for the Atlantic coast are those of Pearse et al. (1942), Dexter (1967, 1969), and Croker (1967). Table II-45 summarizes distribution of species (macrofauna) characteristic of the beach fauna in the area.

The meiofauna has also been investigated. Pertinent sources include those of Pennak (1951), McIntyre (1968), Hulings (1971), and Pollock and Hummon (1971).

Estuarine Bottom Faunal Groups

Salinity is an important factor affecting the distribution of the benthic fauna in estuaries. Given a salinity range, other variables, which include temperature, oxygen, sediment grain size, sediment organic material, and current velocities, determine faunal composition (Pratt, 1973). Hedgepeth (1957) and Carriker (1967) discuss distribution of estuarine species. As a general rule, the number of species decreases as salinity decreases. According to Carriker (1967), there are few true estuarine forms; most are euryhaline forms (30-40°/oo).

Table II-45. Distribution of Selected Beach-dwelling Benthic Organisms

Species	Zone	Source
Polychaetes (worms)		
Nephtys bucera	subtidal	12
N. picta	subtidal	12
Nereis arenaceodonta	subtidal	12
Scolelepsis squamata	low tidal	12
Scoloplas fragilis	low tidal	12
Gastropods		
Polinices duplicatus	subtidal	12
Bivalves (clams)		
Donax fosser	intertidal	6,7
D. variabilis	intertidal	8
Ensis directus	subtidal	12
Spisula solidissima	subtidal	12
Tellina agilis	subtidal	12
Isopoda		
Chiridotea caeca	intertidal	12
Exosphaeroma diminutum	intertidal	12
Amphipods		
Acanthohaustorius millsi	intertidal-subtidal	3,4,5
Amphiporeia virginiana	tidal	4,5
Haustorius canadensis	tidal	4,5
Neohaustorius bioaticulatus	high tidal	4,5
N. schimitzi	intertidal	2
Orchestria grillis	tidal	1
Talorchestria megalopthalma	tidal	1
Decapods (crabs)		
Emerita talpoida	intertidal	9,10,11
Ocypode quadrata (fidler crab)	tidal	1
Ovalipes ocellatus (lady crab)	subtidal	12
Pagurus longicarpus (hermit crab)	subtidal	12

SOURCE: (1) Watling and Maurer, 1972; (2) Dexter, 1967 and 1969; (3) Bousfield, 1965; (4) Croker, 1970; (5) Sameoto, 1969; (6) Jacobson, 1955; (7) Miner, 1950; (8) Wass, 1965; (9) Snodgrass, 1952; (10) Pearce et. al., 1942; (11) Williams, 1965; (12) Pratt, 1973.

Boesch (1971) identified "estuarine endemic" species for Chesapeake Bay. Those common in the Mid-Atlantic area include:

Polychaetes: Scolecolipides viridis and Hyaniola grayi

Gastropod: Hydrobiae sp.

Bivalve: Macoma balthica

Isopods: Cyathura polita and Chiridotea almyea

Amphipods: Gammarus tigrinus and Leptocheirus plumosus

A distinct and dominant faunal element in Mid-Atlantic estuaries is the genus Ampelisca community (Pratt, 1973). They have been described for several locations by various investigators (Table II-46). Their community structure is summarized in Table II-47. Ampelisca communities are an important food source for fish, especially the juvenile stages. Sanders et al. (1972) and Pearce (1970) have found that amphipods are sensitive to hydrocarbon and general organic pollution (Pratt, 1973).

A listing of characteristic bottom fauna of the mid-Chesapeake Bay area is presented in Table II-48 from a survey in Somerset County, Maryland.

Table II-46. Maximum Numbers of *Ampelisca* Species Reported from Atlantic coastal areas (Pratt, 1973)

Location	Density/m^2	Species	Source
Barnstable Harbor	43,200	*A. abdita*	(Mills, 1967)
Buzzards Bay	31,628	*A. "spinipes"*	(Sanders, 1958)
Narragansett Bay	1,070	*A. "spinipes"*	(Phelps, 1958)
	9,780	*A. "spinipes"* (average)	(Strickney and Stringer, 1957)
Long Island Sound	1,885	*A. abdita*	(Sanders, 1956)
	1,306	*A. vadorum*	(Sanders, 1956)
Great Bay, N.J.	10,000	*A. abdita*	(Durand and Nadeau, 1972)
Rhode Island	35,390	*A. agassizi*	(Pratt, Unpublished)
	18,330	*A. agassizi*	(Pratt, Unpublished)

Table II-47. Species Associated with the Ampelisca Community

Species	Source
Polychaetes (worms)	
Clymenella zonalis	5
Glycera americanus	4
Nepytys bucera	4
N. incisa	1,3
Notomastus latericeus	7
Pectinaria gouldii	1,2
Polydora ligni	6,7
Prionospio heterobranchia	6
Pygspio elegans	6
Spiochaetopterus oculatus	2,5
Tharynx acutus	2
Gastropods (Snails & whelks)	
Nassarius obsoletus	6
Retusa canaliculata	2,3
Bivalves (clams)	
Cerastoderma pinnulatum	4
Gemma gemma	6
Lucina multidineata	5
Lyonsia hyalina	1,5
Macoma tenta	2
Mulinia lateralis	1,2,3
Nucula sp.	2,3
Pitar morrhuana	1,2
Tellina tenera	4
Isopod	
Edotea montosa	3,6
Amphipods	
Byblis serrata	4
Corophium sp.	2,7
Erichthonius braziliensis	1
Leptocheirus pinguis	1
Decapod (crabs)	
Ogyrides linicola	5

Source: (1) Sanders, 1956; (2) Strickney and Stringer, 1957; (3) Phelps, 1953; (4) Sanders, 1958; (5) Stone, 1963; (6) Mills, 1969; (7) Durand and Nadeau, 1972.

Table II-48 Sampling area data with dominant invertebrates from tidewater in Somerset County, Maryland. (Pfitzenmeyer, 1961)

Area	Water Depth Sampled (ft.)	Major Bottom Type	Surface Temp. C. (1959)	Surface Salinity ‰ (1959)	Dominant Organisms (1959)
1. Monie Bay	3-6	Silt inshore, mud to sandy mud off-shore.	30.2	10.2	Tagelus Gylcera
2. Deal Island	3-5	Muddy sand to sand over fibrous peat.	29.5	14.6	Amphitrite Tagelus Pectinaria
3. Little Deal Island	3-6	Sand and muddy sand over clay.	30.0	15.1	Glycera Nassarius
4. Manokin River North	3-6	Muddy sand and sandy mud with mud inshore.	30.0	14.6	Tagelus Amphitrite
5. Manokin River South	3-5	Sandy mud to sand over coarse gravel occasionally.	32.0	16.0	Leptosynapta Amphitrite Glycera
6. Big Annemessex River North	3-7	Sand to muddy sand mud inshore.	29.5	16.1	Leptosynapta Glycera
7. Big Annemessex	4-6	Sand to sandy mud over clay.	30.0	15.9	Leptosynapta Amphitrite Glycera
8. James Island	5-7	Sandy clay over hard clay.	31.5	17.3	Amphitrite Glycera
9. Little Annemessex River	3-7	Mud to sandy mud to hard clay.	29.5	18.0	Nassarius Glycera
10. Pocomoke Sound	3-8	Soft mud inshore to sandy mud. Some clay and muddy sand areas.	28.8	16.7	Tagelus Glycera
11. South Marsh Island	3-9	Soft mud to sandy mud over clay. Sand offshore.	29.7	15.8	Nassarius Pectinaria
12. Smith Island	3-9	Soft mud inshore. Clay to sand on exposed shores.	30.0	17.0	Amphitrite Glycera Tagelus

Figure II-50. Diagram of sampling area for above list of dominant invertebrates from tidewater in Somerset County, Maryland. (Pfitzenmeyer, 1961)

Embayments

Embayments are very important in the Mid-Atlantic coastline in that they serve as spawning areas for many offshore fish species, as well as supporting their own year-round resident population. Four extensive embayment/lagoon studies show that the benthic fauna within these environments are similar over the Mid-Atlantic area (Pratt, 1973). Table II-49 summarizes species common to this habitat. Pratt (1973) reports that the embayment fauna is not a well structured or stable community due to environmental changes which repeatedly occur. Temperature, salinity, sediment variables, and aquatic plants undergo both short- and long-term changes. Benthic species having planktonic larvae are thus characterized by different year classes.

Brackish Water Fauna

A distinct faunal division is found in estuarine habitats with salinities above and below 18°/oo (Pratt, 1973). Levels of stress are high in this environment as salinities fluctuate widely as do temperature, oxygen concentrations, and organic loading. Table II-50 summarizes various investigations of this fauna in the Mid-Atlantic region.

Epifaunal Assemblages

The epifauna is comprised of animals living on or in association with solid substrates, such as rock, pebbles, shells, vegetation, or man-made structure (Pratt, 1973). The epifauna includes both economically (discussion in commercial species) and

Table II-49. Selected Bay-dwelling Benthic Organisms

Species	Habitat	Source
Polychaetes (worms)		
Cymenella torquata	sand flats	8
Heteromastis filiformis	sand flats	3,8
Pectinaria gouldii	sand and mud flats	6,7
Prionospio malmgreni	sand flats	3
Gastropods (snails & whelks)		
Cylichna oryza	soft mud	5
Hydrobia minuta	sand flats	5
Lucuna vincta	sand flats	5
Nassarius obsoletus	sand flats	8
Bivalves (clams)		
Crassostrea virginira	shell beds and stones	9
Gemma gemma	sand flats	3,5
Macoma tenta	soft mud	5
Mercenaria mercenaria	sand flats	1,2,4
Mya arenaria	sandy mud or sand	9
Mulinia lateralis	sand flats	6,7
Mytilus edulis	sand flats	1,4
Pitar morrhuana	sand flats	8
Rangia cuneata	sandy mud	9
Tellina agillis	sand flats	6,7
Yoldia limatula	soft mud	5
Ostracod (minute bivalves)		
Cylindroleberis mariae	sand flats	3
Decapods (crabs, shrimp)		
Callinectes sapidus	gravel, mud, sand	10
Uca sp.	mud, sand	10
Palaemontes sp.	sand, mud	10
Crangon sp.	sand, mud	11
Cumaceans		
Leucon americanus	soft mud	5
Oxyurostylis smithi	sand flats	5
Tanaid		
Leptochelis dubia	sand flats	3
Amphipods		
Elasinapus laevis	sand flats	6,7

Source: (1) Ryther, 1954; (2) Wells, 1957; (3) Phelps, 1964; (4) U.S.F. P.C.A., 1967; (5) Parker, 1969; (6) Phillips, 1971; (7) Lovelan 1972; (8) O'Connor, 1972; (9) Lippson, 1973; (10) Williams, 1973; (11) Price, 1962.

Table II-50. Selected Brackish Water-Dwelling Benthic Organisms

Species	Source
Polychaetes (worms)	
Amphitrite ornata	1
Hypaniola grayi	3
Neanthes succinea	2,3,4,5
Polydora ligni	2,3,4
Pygospio elegans	3
Scolecolepides virides	6
Streblospio benedicti	2,3,4
Gastropods (snails)	
Hydrobia sp.	3
Nassarius obsoletus	4
Bivalves (clams)	
Crassotrea virginica	7
Gemma gemma	3
Macoma balthica	2,3,4,5
M. phenax	7
Mya arenaria	2,4,5
Tagelus plebius	1
Cirriped (barnacles)	
Balanus improvisus	2
Cumacea (minute crustacean)	
Almyracuma proximoculi	3
Tanaid	
Leptochelia sp.	3
Isopods (crustacean)	
Cyathura polita	2,3,6
Edotea triloba	3
Amphipods (crustacean)	
Gammarus tigrinus	3
Leptocheirus plumulosus	3,6
Decapod (crustacean)	
Phithropanopeus harrisii	5
Holothuroid (sea cucumber)	
Leptosynapta inhaerens	1

Source: (1) Pfitzenmeyer, 1961; (2) Dean and Haskin, 1964; (3) Sanders, et al., 1965; (4) Wass, 1967; (5) Hanks, 1968; (6) Pfitzenmyer, 1970; (7) Carter, III, W. R., State of Maryland, per. comm., 1975.

ecologically important species. This assemblage is divided into three categories for discussion.

Intertidal

Along the Mid-Atlantic coast, bedrock shorelines are very rare. Boulder and pebble covered shorelines are more common, however.

From New Jersey southward, man-made structures, such as jetties, buoys, wrecks, piles, and groins, are more common and provide intertidal substrates (Pratt, 1973).

Vertical distribution of intertidal organisms depends on tidal range and wave exposure. A tidal range of 4-5 feet is common to the open coast of the area, as well as to Delaware Bay (Pratt, 1973).

Due to the accessibility of the intertidal fauna, they are well known taxonomically and physiologically. Most studies pertaining to this fauna have been carried out in other areas but are generally applicable to the Mid-Atlantic areas as many of the species are the same or related (Pratt, 1973). References include those of Paine, 1969; Connell, 1961, 1970; Newell, 1970; Dayton, 1971; and Harger, 1972.

Few quantitative studies have been done for the area. Table II- 51 summarizes some of the organisms of the intertidal fauna.

Table II- 51. A Partial List of Epibenthic-Intertidal Organisms (Abstracted from Pratt, 1973)

Species

Demospongia (sponge)
Cliona sp.

Hydrozoa
Hydroids

Anthozoa
Anenomes

Turbellaria (cilia-covered worm)
Stylochus ellipticus

Polychaetes (worms)
Amphitrite ornata
Neanthes succinea
Polydora websteri

Gastropods (snails & whelks)
Crepidula sp.
Eupleura caudata
Littorina irrorata
L. littorea
L. obtusata
L. saxatilis
Odostomia sp.
Thais lapillus
Urosalpinx cinerea

Bivalves (clams)
Anomia sp.
Crassostrea virginica
Mytilus edulis

Cirripeds (barnacles)
Balanus balanoides
Chthamalus fragilis

Amphipods (crustaceans)

Decapods (crustaceans)
Pinnotheres ostreum

Bryozoans (sea mats)

Asteroidea (starfish)
Asterias forbesii

Echinoidea
Urchins

Tunicates (sea squirts)

Subtidal fauna

The subtidal epifaunal communities are not well known. Most subtidal investigations have been in regards to fouling of surfaces. Species in this component include:

Demospongia: *Cliona celata*

Hydrozoa: *Tubularia crocea*

Anthozoans: *Astrangia danae*, *Metridium senile*

Gastropod (snails): *Crepidula fornicata*

Bivalves (clams): *Anomia simplex*, *Mytilus edulis*

Cirripeds (barnacles): *Balanus balanoides*, *B. eburneus*, *B. improvisus*, *Lepas anatifera*

Amphipods (crustaceans): *Corophium lacustre*

Epiphytic Fauna

Aquatic plants create a unique habitat in the Mid-Atlantic area. Some faunal forms associated with this habitat are widespread in their distribution but many are restricted to this habitat. Mulkana (1966) reports that dense Zostera beds provide shelter and food for juvenile fish. Sediments surrounding these beds have a higher organic content and support higher densities of infaunal species (Phelps, 1964; Marshall and Lukas, 1969).

Brown (1962), Nagle (1965, 1968), and Marsh (1970) report that the following species are characteristic to this habitat:

Polychaete: (worms)	Polydora ligni
Gastropods: (snails)	Bittium alternatum, B. varium, Crepidula convexa, Lacuna vincta
Cirriped: (barnacles)	Balanus improvisus
Isopod: (crustaceans)	Erichsoniella attenuata
Amphipods: (crustaceans)	Amphitae longimana, Corphium sp., Dexamine thea, Gammarus sp., Microdeutopus dammoniensis
Tunicate: (sea squirts)	Molgula manhattensis

The settling of spat, sheltering of juvenile invertebrates and fish is assisted by the availability of eelgrass as a substrate.

d. Fish

Introduction

Fishes, as a group, are less confined to a single habitat than most other marine organisms (TRIGOM, 1974). They are able to respond to changes in the environment quickly, such as seasonal changes, and create a continually changing and shifting population in a given area. The Mid-Atlantic area is generally characterized by warm water species. As compared to more northern latitudes, the area has fewer annual resident species.

Fishes can be categorized according to their principal mode of existence into the following (TRIGOM, 1974):

Pelagic fishes - range widely throughout the water column, feeding on plankton and fish, herrings and mackerels for examples of the latter.

Demersal fishes - associated with the bottom, feeding on bottom invertebrates and fishes and usually more restricted in their movements than pelagic species; for example flat-fish and cods.

Nearshore fishes - usually smaller-size species and juveniles of offshore species found in shallow waters that are tolerant of wide temperature changes; for example, sculpins and younger winter flounder.

Estuarine fishes - either transient, diadromous[1] species moving to or from spawning areas, or fishes able to tolerate fluctuating salinity conditions.

As mentioned previously, fishes are a very mobile group and sometimes are difficult to categorize. Demersal or semi-demersal fishes however, seem to dominate in the Mid-Atlantic area due to the large expanse of shallow waters.

Zoogeography

The effects of temperature on the migratory activities of fish populations in shelf waters have been discussed by Parr (1933) and Colton (1972). Mid-Atlantic Bight waters are heterothermal and therefore maintain very few permanent residents and are comprised of continuously shifting populations. These waters have a rich migratory summer population due to thermal compulsion of southern species northward and somewhat less diverse winter population because of a diffusion southward or to the continental slope due to a breakdown of a temperature barrier at Cape Cod (TRIGOM, 1974). Table II-52 lists migratory characteristics of some species common to the area.

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[1]Migratory between fresh and salt water.

Table II-52 Seasonal Migration Characteristics of Some Important Fish Species (TRIGOM, 1974)

I. Southern summer migrants (north to Cape Cod)

Summer flounder	*Paralichthys dentatus*
Scup	*Stenotomus chrysops*
Weakfish	*Cynoscion regalis*
Kingfish	*Menticirrhus saxatilis*
Mullets	*Mugil sp.*
Black seabass	*Centropristes striata*
Filefishes	*Aluterus sp.*, *Monacanthus sp.*
Pompanos	*Caranx hippos* and other species
Northern puffer	*Sphaeroides maculatus*

II. Northern summer migrants (north into the Gulf of Maine)

Spiny dogfish	*Squalus acanthias*
Silver hake	*Merluccius bilinearis*
Red hake	*Urophysis chuss*
White hake	*U. tenuis*
American shad	*Alosa sapidissima*
Striped bass	*Roccus saxatilis*
Menhaden	*Brevoortia tyrannus*
Bluefish	*Pomatomus saltatrix*
Atlantic mackerel	*Scomber scombrus*
Butterfish	*Peprilus triacanthus*
Bluefin tuna	*Thynnus tynnus*

III. Southern winter dispersal

Atlantic herring	*Clupea harengus*
Atlantic cod	*Gadus morhua*
Pollock	*Pollachius virens*

Species Composition

Species taken in surveys for coastal and offshore areas can be found in TRIGOM (1974). Biographical data on commercial species[1] are given in Section II.G.1.f.

Estuaries and Nearshore Areas

The fish fauna of estuarine and nearshore habitats is comprised of year-round residents, juveniles, and diadromous species that use estuaries as pathways to and from spawning areas. Smith (1973) reports that many marine species are dependent on estuaries and embayments in that they provide an essential habitat. It has been estimated by Clark et al. (1973) that 60 to 70 percent of economically important Atlantic species inhabit estuarine environs. Gunter (1961) reports that estuaries are important as nursery grounds for juveniles of many species. The number of fish species is known to decline with distance up the estuary.

TRIGOM (1974) has summarized Pearcy and Richards (1962), McHugh (1967), and Lebida (1969) in order to categorize the fish fauna of estuaries in the area:

(1) Fresh water fish that stray into brackish and salt water.

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[1]Species distributions are shown on Visual 4.

(2) True estuarine species that are able to adapt to wide changes in salinity that are characteristic of upper estuarine waters.

(3) Diadromous species that use the estuaries as pathways to and from spawning grounds.

(4) Resident marine species that are common to open waters as well and which are usually only found in the lower estuarine areas of relatively high salinity.

Table II-53 indicates the dominant estuarine fishes of the Chesapeake Bay, an example of the estuarine species in the Mid-Atlantic area.

Table II-53. Dominant Estuarine Fishes of Chesapeake Bay

Weakfish - *Cynoscion regalis*
Atlantic silverside - *Menidia menidia*
Puffer - *Spheroides maculatus*
Winter flounder - *Pseudopleuronectes americana*
Hogchoker - *Trinectes maculatus*
Bay anchovy - *Anchoa mitchilli*
American shad - *Alosa sapidissima*
Blueback herring - *Alosa aestivalis*
Alewife - *Alosa speudoharengus*
Menhaden - *Brevoortia tyrannus*

American eel - *Anguilla rostrata*
Channel Catfish - *Ictalurus punctatus*
Brown bullhead - *Ictalurus nebulosus*
White catfish - *Ictalurus catus*
White perch - *Roccus americanus*
Stripped bass - *Roccus saxatilis*
Yellow perch - *Pecca flovescens*
Bluefish - *Pomatomus saltatrix*
Spot - *Leiostomus xanthurus*
Croaker - *Micropogan undulatus*

Source: Lippson, 1973.

Spawning

Most species require specific times, temperature, and locations for spawning, which, in many cases, is during brief periods and in limited and vulnerable areas (TRIGOM, 1974).

There are two types of eggs produced by externally spawning fishes: demersal eggs which sink and are associated with the bottom substrate, and planktonic eggs which float freely in the water column near the surface (TRIGOM, 1974). Demersal eggs, for the most part, are laid by species whose life history is associated with the shallow, inshore areas of estuaries (Pearcy and Richards, 1962; Geason, 1969; Clenoweth, 1973). Pelagic species that lay demersal eggs, as the Atlantic herring, do so on shallow coast and bank areas. Planktonic eggs are usually laid by fishes that range widely over the Continental Shelf. Many of these species spawn over a very wide area and over a longer period of time. The spawning areas of most of these species are not well defined (TRIGOM, 1974). Table II-54 summarizes spawning characteristics of some species occurring in the Mid-Atlantic area.

For many species, spawning results in an aggregation of fishes in relatively small, well-defined geographic areas which necessitates migration to and from spawning grounds (TRIGOM, 1974). This is especially true for anadromous species such as alewife, blueback herring, and the shads. Successful reproduction for these species depends on passage into fresh water. In open waters, spawning migrations also take place into well-defined areas as with the Atlantic cod, Atlantic herring, haddock, and pollock.

Table II-54. The Spawning Characteristics of Some Species Occurring in the Area (Adapted from TRIGOM, 1974 ; Lippson, 1973)

	Spawning Type	Spawning Time	Spawning Areas
Spiny dogfish *Squalus acanthias*	Ovoviviporous.	Young born in Nov.-Jan. 2nd Year.	Offshore wintering grounds.
Little skate *Raja crinacea*	Fertilization is internal; lays eggs.	All year.	Shoals and offshore banks generally in relatively hard bottom substrates.
Alewife *Alosa pseudoharengus*	Anadromous. Eggs demersal.	Spring.	Ponds and sluggish streams. 13-16°C.
Blueback herring *Alosa aestivalis*	Anadromous. Eggs demersal.	Late spring.	Nearer tidewater than alewife. 20-23°C.
Atlantic herring *Clupea harengus*	Eggs adhesive, demersal. Larvae pelagic.	Sept.-Nov.	Shallow coast & banks, less than 90m. Rocky, gravelly bottom.
Menhaden *Brevoortia tyrannus*	Eggs and larvae pelagic.	May-July and Sept.-Oct.	15-18°C, coastal waters. Rarely above Cape Cod.
Smelt *Osmerus mordax*	Anadromous. Eggs adhesive, demersal; larvae pelagic.	Once a year. March-May.	Fresh or barely brackish coastal streams. 4-12°C.

Table II-54. Continued.

	Spawning Type	Spawning Time	Spawning Areas
American shad *Alosa sapidissima*	Anadromous. Eggs semi-buoyant, not sticky	Spring or early summer. 10-13°C.	Sandy or pebbly shallows.
Mummichog *Fundulus heteroclitus*	Eggs demersal, adhesive.	April-early August.	In a few inches of water, close to shore.
Silver hake *Merluccius bilinearis*	Eggs and larvae pelagic.	June-Sept. Principally in July & August.	Entire coastal zone from Long Is. to Sable Is. Sandy slopes shoaler than 90m. Most important N & E of Cape Cod. 7-12°C.
Atlantic cod *Gadus morhua*	Eggs and larvae pelagic. Seek bottom at 4cm.	Chiefly in winter.	Not below 90m Eastern Georges Bank, Browns Bank, Mass. Bay 3-10 miles offshore, Ipswich Bay
Haddock *Melanogrammus aeglefinis*	Eggs and larvae pelagic.	Feb.-May Peak in March-April.	Broken bottom of mixed rock, gravel, mud and sand. 4-7°C.
Pollock *Pollachius virens*	Eggs and larvae pelagic.	Nov.-March Peak, late Dec.	Chiefly region of Mass. Bay. 27-90m. 6-8°C.
Red hake *Urophycis chuss*	Eggs and larvae pelagic.	Summer.	Relatively shoal water, within 100m isobath.
White hake *Urophycis tenuis*	Eggs and larvae pelagic.	Summer.	Same as red hake.
Atlantic silverside *Menidia menidia*	Eggs, demersal, adhesive. Larvae pelagic.	May-July. Primarily May and early June	Shallow bays marshes, 15-22°C, over sandy bottoms.

Table II-54. Continued.

	Spawning Type	Spawning Time	Spawning Areas
American sand launce *Ammodytes americanus*	Eggs demersal, adhesive.	Autumn and early winter, late Nov.-late march.	Inshore and offshore above 27m. Sandy bottom.
Atlantic mackerel *Scomber scombrus*	Eggs and larvae are pelagic.	Spring-early summer. Peak May-June.	Primarily Chesapeake Bay to Cape Cod, 9-13°C, no spawning grounds.
Butterfish *Peprilus triacanthus*	Eggs and larvae are pelagic.	June-August. Peak in July.	Within a few miles of shore over most of their range.
Bluefish *Pomatomus saltatrix*	Eggs and larvae are pelagic.	May-June.	Offshore, 18m to edge of Continental Shelf, waters warmer than 15°C. Not above Cape Cod.
Striped bass *Morone saxatilis*	Anadromous. Eggs and larvae are pelagic. Eggs semi-buoyant.	May-early June.	Brackish to fresh water of Hudson River, Delaware Bay, & Chesapeake Bay, 14-15°C, as high as 20°C.
Scup *Stenotomus chrysops*	Eggs and larvae are pelagic.	May-August Peak May-mid-July.	Estuaries, bays and inshore waters, 18-20°C. Not above Cape Cod.
Weakfish *Cynoscion regalis*	Eggs-buoyant	May-Oct. Peak mid-May to mid-June.	Large estuaries of near their mouths. Not above Cape Cod.
Kingfish *Menticirrhus saxatilis*		June-August.	Bays and sounds. Not above Cape Cod.
Longhorn sculpin *Myoxocephalus octodecimspinosus*	Eggs-demersal, adhesive.	Nov.-Feb. Peak late Dec.-Jan.	Throughout their range.

Table II-54. Continued.

	Spawning Type	Spawning Time	Spawning Areas
Cunner *Tautogolabrus adspersus*	Eggs and larvae are pelagic.	May-Oct.	Throughout their range, coastal, 10-11°C.
Tautog *Tautoga onitis*	Eggs and larvae are pelagic.	Early to mid-summer. May-August.	Lower estuaries and shallow coastal areas. Chiefly below Cape Cod.
Summer flounder *Paralichthys dentatus*	Eggs and larvae are pelagic.	Sept.-Feb. in a north to south progression. Early Sept. for the Gulf of Me.	Deep water within 46km of shore, 12-19°C.
Winter flounder *Pseudopleuronectes americanus*	Eggs sink and adhere (demersal, non-buoyant). Larvae have mixed planktonic-benthic behavior.	Jan.-May.	In shoal water, 7m in backwaters of bays and estuaries and on Georges Bank at 45m-72m, 5°C. Sandy bottom.
Yellowtail flounder *Limanda ferruginea*	Eggs and larvae are pelagic.	March-August	Water 46 to 64m deep, over sand bottom.
American plaice *Hippoglossoides platessoides*	Eggs and larvae are pelagic.	March-June. Peak April-May.	From inshore to the 180m contour. 3-5°C. Throughout its range.
Witch flounder *Glyptocephalus cynoglossus*	Eggs buoyant. Larvae pelaic for 4-6 months.	Late spring-summer. Peak July-August.	Throughout the Gulf of Maine and the offshore banks.
Atlantic halibut *Hippoglossus hippoglossus*	Eggs and larvae are pelagic.	Jan.-June. Peak March-May.	Spawn on bottom.
Redfish *Sebastes marinus*	Eggs develop and hatch within the oviduct. Larvae pelagic.	Peak late June to early July.	Both inshore and offshore. Rocky and hard grounds. 2-9°C.

Table II-54. Continued.

	Spawning Type	Spawning Time	Spawning Areas
Ocean pout *Macrozoarces americanus*	Eggs laid in gelatinous masses. Larvae demersal.	Sept.-Oct.	Rocky bottoms. Congregate for spawning.
Northern puffer *Sphaeroids maculatus*	Eggs demersal and adhesive.	Mid-May through summer.	Shoal water, close to shore. Not above Cape Cod.
American eel* *Angrilla rostrata*	Anadromous	Winter	Sargasso Sea.
Channel cat* *Ictalurus punctalus*	Eggs in adhesive clumps	April	Freshwater nests.
White perch* *Morone americanus*	Adhesive eggs.	March-April	Freshwater of estuaries
Yellow perch* *Perca flonescens*	Adhesive gelatinous strands of eggs/ freshwater	February-March	Freshwater
Spot* *Leiostomus xantherus*	Pelagic eggs. Larvae swims into Chesapeake and other bays.	January-April	Spawns at sea; larvae enter bay or estuary.
Croaker* *Micropogia undulatus*	Pelagic eggs.	August-December.	Spawns at sea; larvae enters estuary.
Hogchoker* *Trinectes maculatus*	Pelagic eggs.	May-September	Lower reaches of rivers and bays.
Bay anchovy* *Anchoa mitchilli*	Pelagic eggs.	April-September	Lower reaches of rivers and bays.

*Primarily bay species.

The planktonic period for most fishes occurs during the spring and summer months and lasts for approximately 3 to 5 months (Bigelow and Schroeder, 1953; Colton and Temple, 1961). They are an important component of the seasonal plankton during this period in estuaries and shallow coast areas.

Tables II- 55 and II-56 summarize several surveys on the composition and abundance of planktonic fish eggs and larvae for the coastal, offshore, and estuarine zones of the area. It must be kept in mind that since the Mid-Atlantic area is characteristically comprised of migratory species, eggs and larvae of some species are not reported in the area. For the most part, however, the species composition of eggs and larvae in any region reflects the composition of fish species that are common to the region (TRIGOM, 1974). This seems to be especially true of nearshore species that spawn in estuaries.

Juveniles

The greatest number of juveniles occur in the summer and fall after the spring and summer larval periods (TRIGOM, 1974). Juveniles will seek bottom if they are demersal species or swim in the water column if they are pelagic. In both cases, however, they tend to concentrate in protected environs. The estuarine and nearshore environments are a very common and essential habitat for juvenile fishes that normally occur in offshore areas as adults (TRIGOM, 1974). Clark (1967) reports that two of every three species of economically important Atlantic fish depend on tidal lands and bays for survival and also, to a large extent, oceanic fishes in their early stages. It has also been observed that juveniles are more euryhaline than adults and are distributed farther up the estuaries.

Table II- 55. Species Composition and Relative Abundance (Percent) of Fish Larvae from Coastal and Offshore Surveys (adapted from TRIGOM, 1974)

		Percent Occurrence	
		Wheatland 1956	Merriman & Sclar 1952
American sand launce	Ammodytes americanus	34.40	
Anchovy	Anchoa mitchilli mitchilli	45.68	
Butterfish	Poronotus triacanthus		0.49
Atlantic cod	Gadus morhua		1.71
Cunner	Tautogolabrus adspersus	1.09	22.44
American eel	Anguilla rostrata	0.07	
Atlantic herring	Clupea harengus harengus	0.07	3.90
Lumpfish	Cyclopterus lumpus		3.90
Atlantic mackerel	Scomber scombrus		1.71
Atlantic menhaden	Brevoortia tyrannus	10.20	
Squirrel hake	Urophycis chuss		17.80
Fourbeard rockling	Enchelyopus cimbrius	0.54	
Scup (porgy)	Stenotomus chrysops	0.27	0.24
Longhorn sculpin	Myoxocephalus octo-decimspinosus	0.68	4.15
Silver hake	Merluccius bilinearis		3.90
Northern searobin	Prionotus carolinus	0.14	
Wrymouth	Cryptacanthodes maculatus		0.49
Weakfish	Cynoscion regalis	0.95	23.66
Windowpane	Scophthalmus aquosus	1.16	0.98
Winter flounder	Pseudopleuronectes americanus	4.28	
Yellowtail flounder	Limanda ferruginea	0.07	10.73
Northern pipefish	Syngnathus peckianus	0.07	0.24
Silverside	Menidia menidia	0.07	
Northern kingfish	Menticirrhus saxatilis	0.07	
Tautog	Tautoga onitis	0.07	0.73
Fourspot flounder	Paralichthys oblongus	0.07	
Northern puffer	Sphaeroides maculatus	0.07	
Lined seahorse	Hippocampus erectus		0.24
Grubby	Myoxocephalus aeneus		1.71
Summer flounder	Paralichthys dentatus		0.98

Table II-56. Specimens composition and relative abundance (percent) of fish larvae from estuarine surveys (Adapted from TRIGOM, 1974)

		Herman 1963	Croaker 1965	Pearcy and Richards 1962
Atlantic herring	*Clupea harengus*	0.03	12.14	
Atlantic menhaden	*Brevoortia tyrannus*	4.73	0.21	0.02
Bay anchovy	*Anchoa mitchelli*	7.88	6.57	1.48
American eel	*Anguilla rostrata*	0.09	45.74	
Silver hake	*Merluccius bilinearis*	0.42		
Atlantic cod	*Gadus morhua*	3.50		
Haddock	*Melanogrammus aeglefinis*	0.04		
Hakes	*Urophycis* sp.	1.18		
Fourbeard rockling	*Enchelyopus cimbrius*	0.01	0.12	
Summer flounder	*Paralichthys dentatus*	0.22		0.01
Fourspot flounder	*Paralichthys oblongus*	0.28		
Winter flounder	*Pseudopleuronectes americanus*	2.05	9.27	72.88
Windowpane	*Scophthalmus aquosus*	1.63	0.58	0.01
Hogchoker	*Trinectes maculatus*	0.01		

Table II- 56. Continued.

		Herman 1963	Croaker 1965	Pearcy and Richards 1962
Atlantic silverside	*Menidia menidia*	5.83	4.57	0.06
Threespine stickleback	*Gasterosteus aculeatus*	0.01		0.03
Northern pipefish	*Syngnathus fuscus*	3.82	8.32	0.28
Butterfish	*Poronotus triacanthus*	4.09	0.08	
Bluefish	*Pomatomus saltatrix*	0.01		
Black seabass	*Centropristes striatus*	0.03		
Scup	*Stenotomus chrysops*	4.14		0.05
Weakfish	*Cynoscion regalis*	0.83		
Northern kingfish	*Menticirrhus saxatilis*	0.32		
Sculpins	*Myoxocephalus sp.*	27.28	0.25	
Lumpfish	*Cyclopterus lumpus*	0.61		0.59
Northern searobin	*Prionotus carolinus*	3.60		0.02
Cunner	*Tautogolabrus adspersus*	8.11		0.48

Table II- 56. Continued.

		Herman 1963	Croaker 1965	Pearcy and Richards 1962
Tautog	Tautoga onitis	2.63	0.04	0.11
Goby	Gobiosoma sp.	0.66	0.08	0.02
American sand launce	Ammodytes americanus	12.31	11.14	0.24
Rock gunnel	Pholis gunnellus	1.43		1.41
Radiated shanny	Ulvaria subbifurcata	1.05		
Wrymouth	Cryptacanthdes maculatus	0.01		
Northern puffer	Sphaeroides maculutus	1.18	0.12	0.01
Mummichog	Fundulus heteroclitus		0.33	0.01
Pollock	Pollachius virens		0.12	0.01
Spotled seahorse	Hippocampus erectus	0.08		
Atlantic croaker	Micropogon undulatus	0.08		
Rainbow smelt	Osmerus mordax		0.20	
Inshore lizardfish	Synodus foetens		0.02	

Table II-56. Continued.

		Herman 1963	Croaker 1965	Pearcy and Richards 1962
Conger eel	Conger oceanicus			0.02
Tomcod	Microgadus tomcod		16.19	
Fourspine stickleback	Apeltes quadracus		0.15	
Grubby	Myoxocephalus aeneus		5.60	
Oyster toadfish	Opsanus tau		0.03	

Several investigations report the dominance of juvenile fishes in the nearshore environment (Richards, 1963; Jerome et al., 1965; Fiske et al., 1966; Lux and Nicky, 1971; McCleave, 1972).

Food and Feeding

Fishes are of three very general feeding types according to Ricker (1946): plankton feeders, bottom feeders, and fish eaters. Arvidson (1974), for 18 species of demersal fishes sampled from Nova Scotia to Hudson Canyon, reports that the five most important prey groups were fish, crustaceans, annelids, molluscs, and echinoderms. The crustaceans are reported to be the most important. More general food habits are given by Nichols and Breder (1927), Bigelow and Schroeder (1953), and Leim and Scott (1966). Table II-57 lists the major food groups of fishes.

Many fishes are considered to be generalists and opportunistic in their feeding habits. Some studies on stomach content have revealed a wide variety of food items (Bigelow and Schroeder, 1953). Other studies indicate, however, that the bulk of food intake is restricted to a few species (Richards, 1963; Poole, 1964; Kohler and Fitzgerald, 1969; Tyler, 1972). Tyler (1972) reports the division of food species for thirteen common species in Maine. He demonstrated that although most of the fishes feed on a wide range of organisms, only a few species make up the bulk of their diet and that there is little overlap of food species among resident fishes (Table II-58). This has also been reported for other areas, notably, by Merriman and Warfel (1948), Richards (1963), and McCleave (1972).

Table II-57. The Most Common Groups of Food Organisms of Fishes (TRIGOM, 1974)

Pelagic fish

Plankton in general, planktonic crustaceans (calanoid copepods, mysids, euphausiids, shrimp)

Fish eggs and larvae and other elements of the meroplankton

Small schooling fish (sand launce, herring, menhaden, young or other pelagic species)

Cephalopods

Demersal fish

Benthic crustaceans (amphipods, shrimp, crabs, lobsters)

Annelid worms

Molluscs

Echinoderms

Small bottom fishes (young flounder, silversides, mummichog)

Demersal fish - scavengers

Any of the above food groups of demersal fish

Organic detritus

Plants (seaweed, eelgrass, diatoms)

Table II-58. Percentage by Weight of Stomach Contents Comprised by Principal Prey after Tyler (1972) (TRIGOM, 1974)

Predators	Mar.-Apr. 1965	May-Nov. 1965	Dec.-April 1965-66	May-June 1966
Atlantic cod	81%	80%	68%	36%
Longhorn sculpin	49%	69%	72%	52%
American plaice	--	87%	67%	90%
Winter flounder	83%	85%	--	77%
Haddock	--	82%	61%	70%
Throny skate 40 cm	84%	79%	95%	--
Throny skate 40 cm	97%	93%	93%	--
Little skate 45 cm	22%	--	63%	--
Little skate 45 cm	94%	--	89%	--
Pollock	--	--	99%	--
Winter skate	--	--	96%	--
White hake 27 cm	--	94%	--	--
White hake 27 cm	--	95%	--	--
Silver hake	--	97%	--	--
Fourbeard rockling	--	89%	--	--
Ocean pout	76%	75%	--	77%

Division of food sources is also reported within a species for different growth stages. This has been reported by Bigelow and Schroeder (1953), Parker and Larkin (1959), Marak (1960), Steele (1963), Wigley and Theroux (1965), and Tyler (1972).

Generally, the heaviest feeding activity of fishes occurs during the early summer. This is largely due to a greater metabolic demand brought about by warm water and is also the post-spawning period when reserves are low and have to be replenished. Investigations include those of Wigley (1965), Fraser (1970), and Glebe (1974).

Pollution

Fish populations are subject to a variety of man-made stresses which increase year by year. The stresses are usually associated with the deterioration and contamination along the immediate coast (TRIGOM, 1974). As was mentioned previously, a majority of fishes, especially commercial, are dependent on nearshore areas and will therefore be affected by any environmental changes. The most obvious case is the elimination of spawning runs throughout the area.

Fish that spawn on the bottom in shallow coastal and bank areas are also vulnerable to the damage of their eggs through ocean dumping, dredging, dredge spoil disposal, and bottom trawling (TRIGOM, 1974). The impact on fishes of industrial wastes, pesticides,

oil and other contamination is also of increasing concern and will be discussed in a later section (Section III B.2.).

Environmental systems and pollution areas are illustrated for Virginia, Maryland, Delaware, New Jersey and New York coastal areas on Figures II-51 through II- 53.

Endangered Fish Species

Shortnose Sturgeon (Acipenser brevirostrum) - Reported in the Hudson and Delaware Rivers. According to TRIGOM (1974), Raney (1973) lists the species as regular in the Delaware River, and probably occurring in every large, unpolluted river along the Atlantic coast.

e. Marine Mammals

Pilson and Goldstein (1973) report that 36 species of marine mammals occur or have occurred within the Mid-Atlantic in historic times. Table II-59 lists those species. Those that occur or have been reported in the area in recent times are noted with an asterisk and are discussed below.

Harbor Seal (Phoca vitulina) - reported in Massachusetts and Rhode Island (Waters and Rivard, 1962; Cronan and Brooks, 1962), Connecticut (Goodwin, 1935), and in New York and North Carolina (Brimley, 1931).

Hooded Seal (Cystophora cristata) - occasional strays have been reported in Massachusetts, Long Island Sound, New Jersey, and North Carolina (King, 1964; Hall and Kelson, 1959).

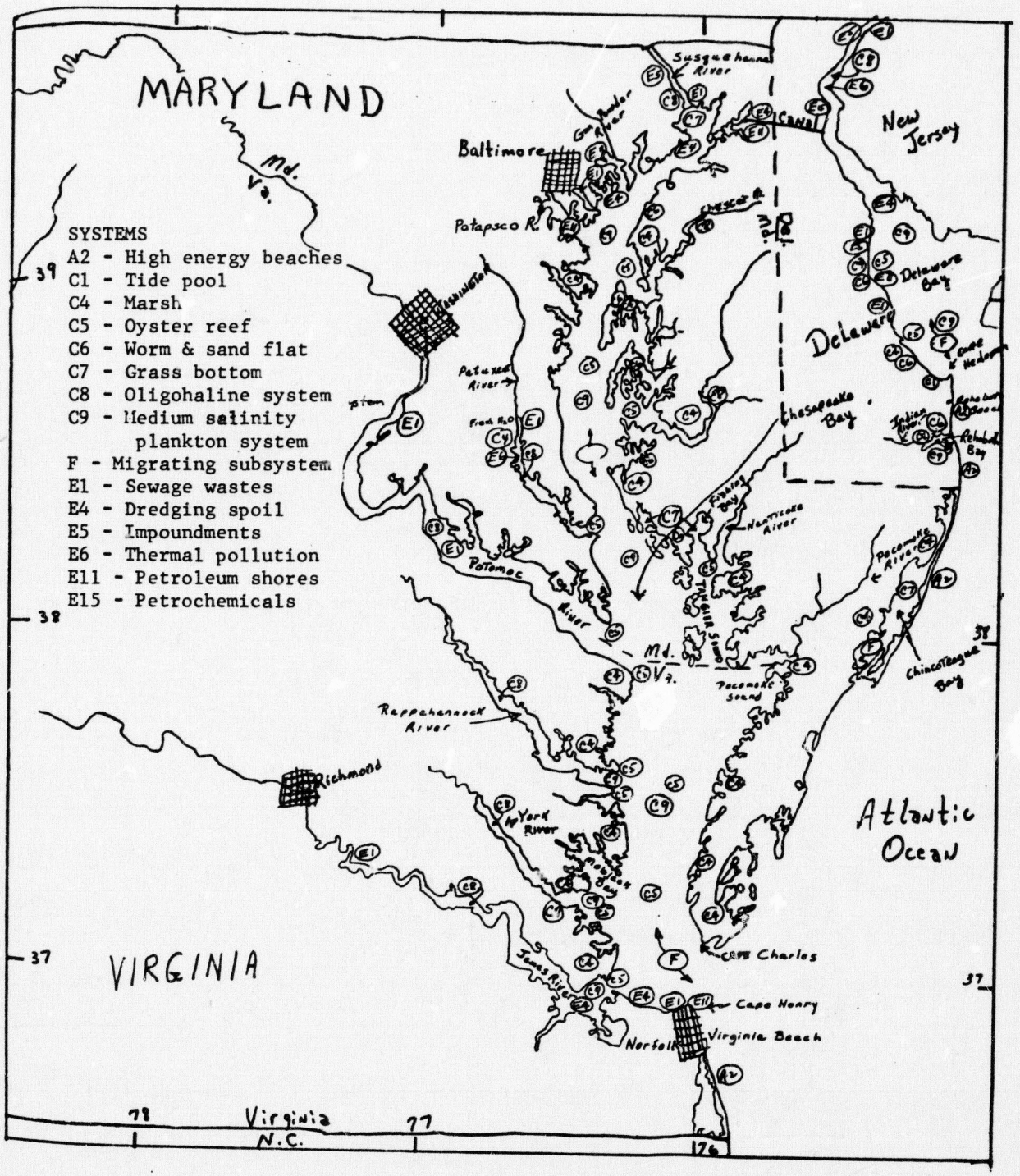

Figure II-51. Environmental sytems and pollution areas of Virginia, Maryland, and Delaware including the Delmarva Peninsula. (Odum et al., 1974)

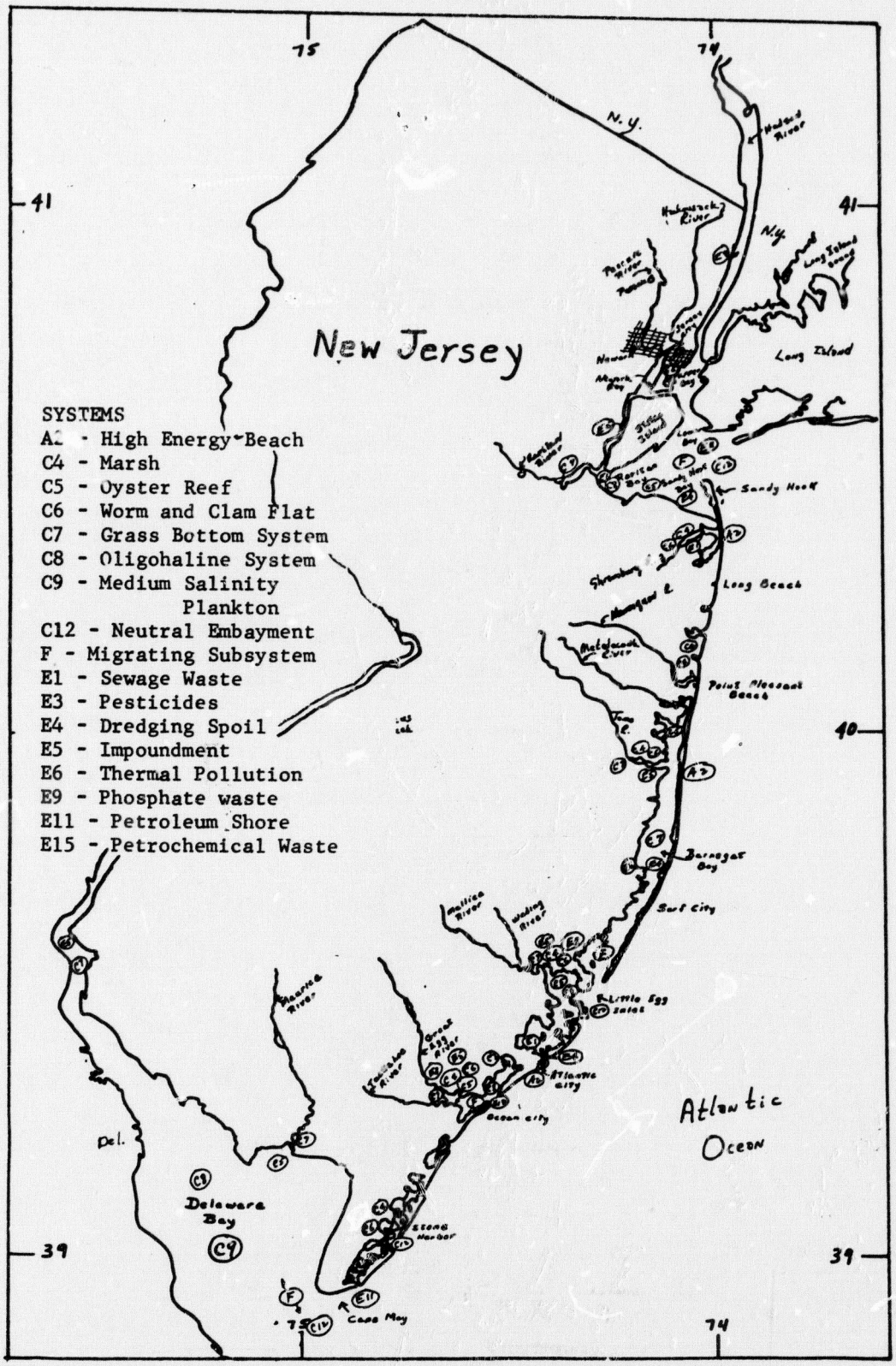

Figure II-52. Environmental systems and pollution areas of New Jersey. (Odum et al., 1974)

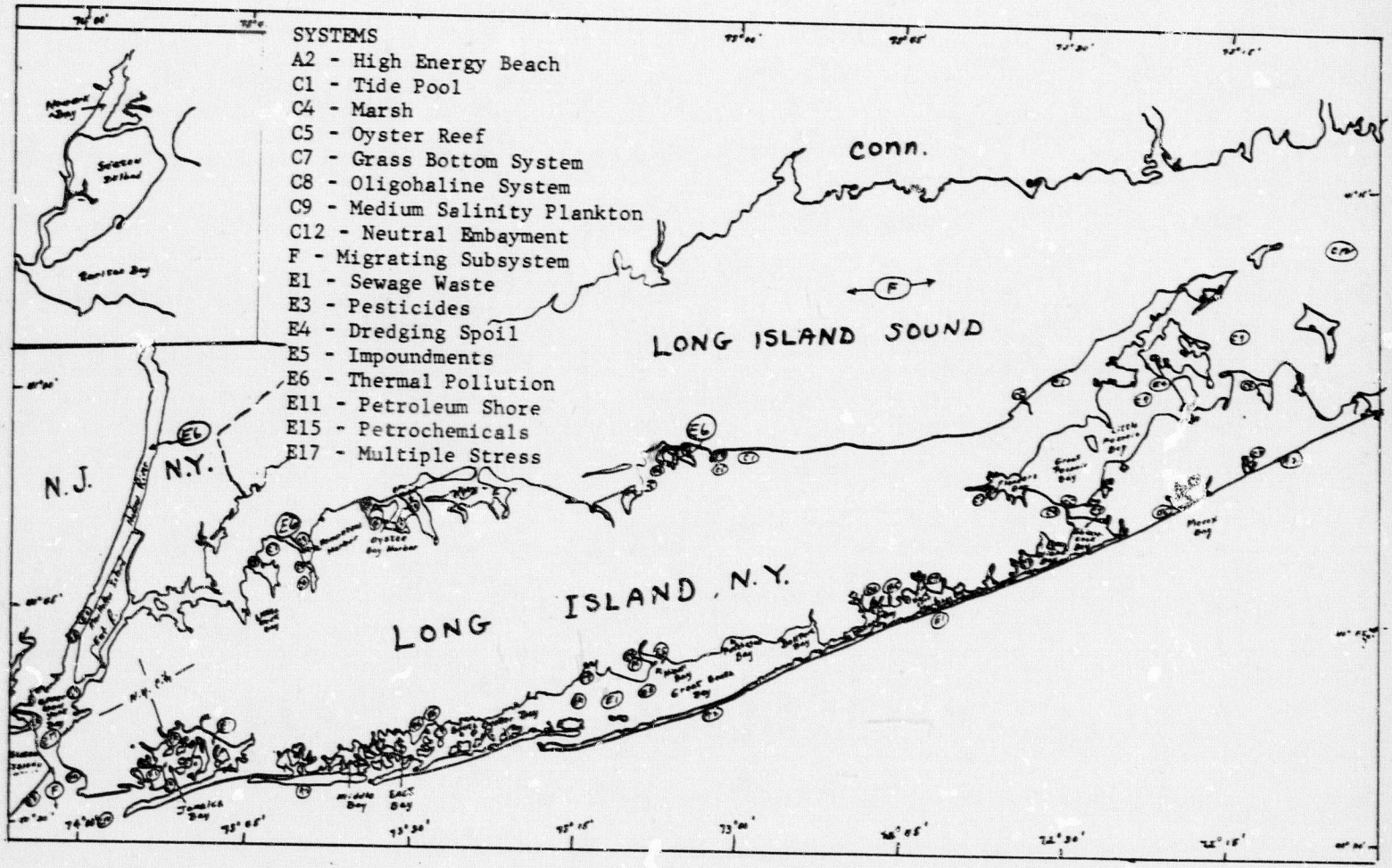

Figure II-53. Environmental systems and pollution areas of Long Island, New York. (Odum et al.,1974)

Table II-59. Marine Mammals Which Have Occurred or May Occur in the Mid-Atlantic (Adapted from Pilson and Goldstein, 1973)

* denotes those that occur or have been reported in the area in recent times.

** denotes those that occur or have been reported in the area in recent times and are "endangered species," (U.S. Department of Interior, 1974)

Odobenidae	
Odobenus rosmarus	Walrus
Phocidae	
*Phoca vitulina	Harbor seal
Halichoerus grypus	Gray seal
Pagophilus groenlandicus	Harp seal
*Cystophora cristata	Hooded seal
Trichechidae	
Trichechus manatus	Manatee
Balaenidae	
*Eubalaena glacialis**	Right whale
Eschrichtiidae	
Eschrichtius robustus	Gray whale
Balaenopteridae	
*Balaenoptera acutorostrata	Minke whale
Balaenoptera borealis	Sei whale
*Balaenoptera physalus**	Fin whale
Balaenoptera musculus	Blue whale
*Megaptera novaeangliae**	Hump-backed whale
Delphinidae	
Steno bredanensis	Rough-toothed dolphin
*Tursiops truncatus	Bottle-nosed dolphin
*Grampus griseus	Grampus or Risso's dolphin
Lagenorhynchus albirostris	White-beaked dolphin
Lagenorphynchus acutus	White-sided dolphin
*Stenella dubia	Spotted dolphin
Stenella caeruleoalba	Striped dolphin
*Delphinus delphis	Common dolphin
Pseudorca crassidens	False killer whale
*Globicephala melaena	Pilot whale
Globicephala macrorrhyncha	Short-finned pilot whale
*Orcinus orca	Killer whale
Phocoena phocoena	Harbor porpoise
Monodontidae	
Delphinapterus leucas	Beluga or white whale
Physeteridae	
Physeter catodon	Sperm whale
*Kogia breviceps	Pygmy sperm whale
Kogia simus	Dwarf sperm whale
Ziphiidae	
Mesoplodon bidens	North Sea beaked whale
*Mesoplodon europeus	Antillean beaked whale
Mesoplodon mirus	True's beaked whale
Mesoplodon densirostris	Dense-beaked whale
*Ziphius cavirostris	Goode-beaked whale
Hyperoodon ampullatus	North Atlantic bottled-nosed whale

Right Whale (Eubalaena glacialis) - classified as endangered by the U.S. Department of the Interior, this species was once pleantiful in the Mid-Atlantic in former days with most recent sightings in the late 1800's. One was reported, however, at Rockaway Beach, Long Island, on August 6, 1975 (Trybulaski, 1975). Sightings are more frequent in the North Atlantic.

Minke Whale (Balaenoptera acutorostrata) - most recent sightings have been in Little Compton, Rhode Island, on June 11, 1961, and off Montauk, Long Island, on August 16, 1930 (Goodwin, 1935; Cronan and Brooks, 1962).

Pilot Whale (Globicephala melaena) and Short-Finned Pilot Whale (Globicephala macrorhyncha) - the two species overlap in the Mid-Atlantic area. G. melaena is commonly sighted in the New England area and can stray south.

Killer Whale (Orcinus orca) - sightings include those of Waters and Rivard (1962) in Rhode Island in 1956, and by Cronan and Brooks (1962) also in Rhode Island.

Pigmy Sperm Whale (Kogia breviceps) - Handley (1966) reports the species as rare but being reported with increasing frequency. Occasional strandings occur in the area. The most recent occurred at Montauk Point, Long Island, on August 8, 1975 (Wegner, 1975).

Antillian Beaked Whale (Mesoploden europacus) - the species is reported to be rare. Rice and Scheffer (1968) lists Long Island as its northern limit. Moore (1966) reports strandings in North Carolina in 1943 and 1956.

Goose-Beaked Whale (Ziphius cavirostris) - reported to be worldwide in distribution but scarce. Waters and Rivard (1962) report a collision with a ship in 1961 and other sightings in Rhode Island.

Fin Whale (Balaenoptera physalus) - classified as endangered by the U.S. Department of the Interior; reported in Drum Inlet, North Carolina, in 1963 (Caldwell and Golley, 1965); Cape Hatteras, North Carolina, in 1961 (Caldwell and Golley, 1965); Assateague Island, Virginia, in 1955 (Paradiso and Handley, 1965).

Hump-backed Whale (Megaptera novaeanglia) - most recent sight in the vicinity was on April 9, 1963, in North Carolina (Caldwell and Golley, 1965). Other sightings include one in 1957 in Rhode Island (Cronan and Brooks, 1962), and in 1955 in North Carolina (Caldwell and Golley, 1965), classified by the U.S. Department of the Interior as an endangered species.

Bottlenosed Dolphin (Tursiops truncatus) - reported to be migratory off the coast of North Carolina (Moore, 1953). Infrequent sightings, however, do not confirm this. A capture is reported in 1965 by Pilson and Goldstein (1973). Paradiso and Handley (1965) report strandings in 1958 and 1964.

Risso's Dolphin (Grampus griseus) - the species is uncommon to the area. One sighting occurred in 1952 south of Block Island.

Spotted Dolphin (Stenella dubia) - more common to warmer waters south. Paradiso and Handley (1965) report one stranding in Maryland in 1956.

Common Dolphin (Delphinus delphis) - common to the area. Individuals are also reported to enter sounds and rivers (Moore, 1953).

2. Onshore

a. Coastal Vegetation

General Forest Regions

Two general forest regions extend along the coast in the Mid-Atlantic area, the oak-pine forest along the coast from Chesapeake Bay to Sandy Hook, New Jersey, and the oak-chestnut forest from Sandy Hook to southern New England (Braun, 1964). Figure II-54 and Visual 4 illustrate their general distribution.

Oak-Pine Forest Region

The oak-pine complex is transitional between the deciduous forests to the north and the evergreen forests to the south. Common pine species include loblolly (Pinus taeda), short leaf (P. echinata), Virginia (P. virginiana), and pitch (P. rigida). Deciduous species are white oak (Quercus alba), black oak (Q. velutina), post oak (Q. stellata), red oak (Q. rubra), southern red oak (Q. Falcata), pignut hickory (Carya glabra), sourwood (Oxydendrum arboreum), and sweet gum (Liquidamber styraciflua).

Species distribution and variation within the association are determined to a large degree by edaphic characteristics and form various associations. Upland sloping and well drained areas are dominated by pine (Pinus spp.) and flat uplands with poor drainage are dominated by oak (Quercus spp.), sweet gum (Liquidamber styraciflua), and sour gum (Nyssa sylvatica) (Halvorson and Dawson, 1973). Upland swamp forest communities are also represented in this complex.

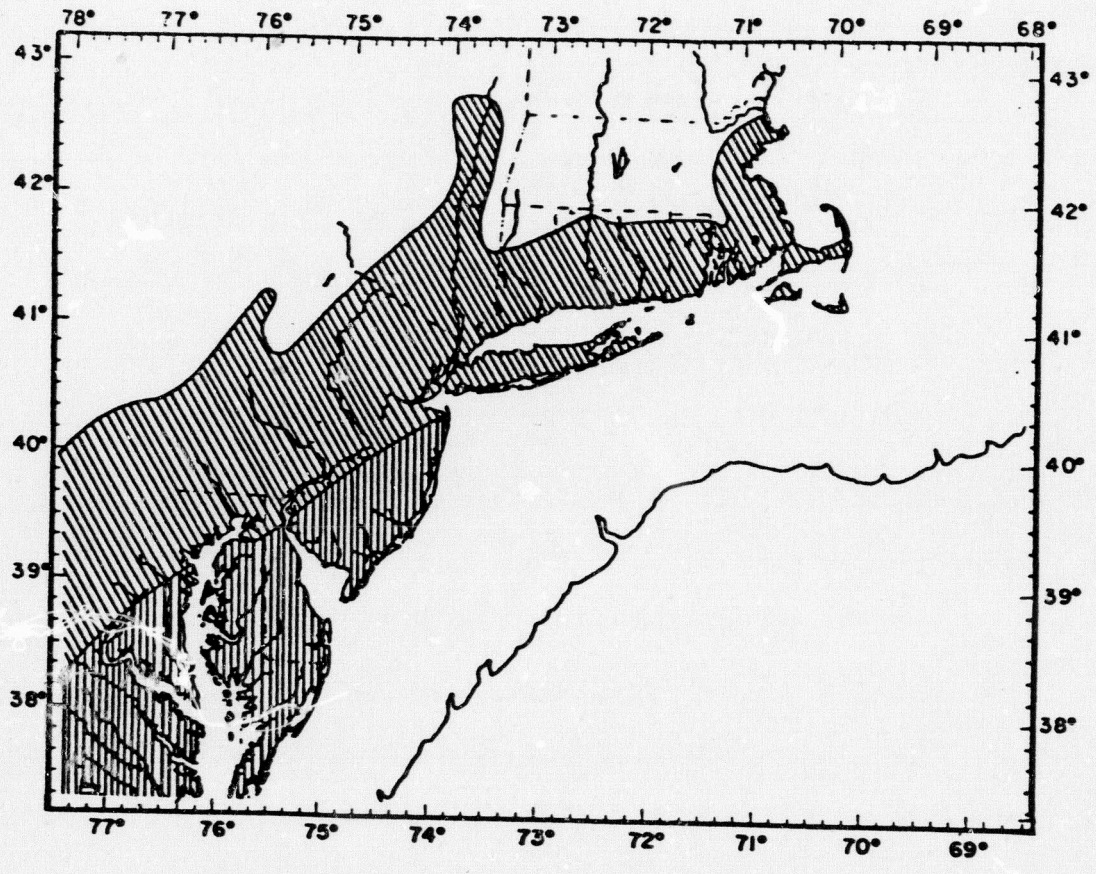

Figure II-54. General Forest Regions of the Mid-Atlantic Coast (Adapted from Halvorson and Dawson, 1973)

Characteristic species include oak (Quercus spp.), sweet gum (Liquidamber styraciflua), red maple (Acer rubrum), flowering dogwood (Cornus florida), American holly (Ilex opaca), sweet bag (Magnolia virginiana), and sour gum (Nyssa sylvatica).

Lowland forests are characterized by a few additional species which occur in areas where water is abundant. They include white cedar (Chamaecyparis thyoides), tulip-tree (Liriodendron tulipifera), and beech (Fagus grandiflora). Bald cypress (Taxodium distichum) also occurs at the southern limits of this complex (Shreve et al., 1910)

The coastal plain of New Jersey is represented in some areas by pine barrens. These areas are characterized by sandy soils, low relief, and usually separated from the coast by a tidal marsh and coastal stand and dunes, behind which are stretches of oaks. Principal species include pitch pine (Pinus rigida) and oak (Quercus spp.) (Braun, 1964).

Oak-Chestnut Forest Region

The southern boundary of this forest roughly coincides with the southern glacial boundary (Braun, 1964). It is primarily and inland forest and becomes coastal in northern New Jersey and areas farther north.

A number of associations are represented in this complex: oak, oak-hickory, oak-chestnut, mixed mesophytic, and Eastern hemlock Tsuga canadensis-hardwood (Halvorson and Dawson, 1973). Oak Quercus spp., are the dominant and most abundant species. Principal swamp species occupying glacially formed depressions include: white cedar (Chamaceyparis thyoides), sweet gum (Liquidamber styraciflua), red maple (Acer rubrum), American elm (Ulmus americana), pin oak (Quercus palustris), white oak (Q. alba), and sour gum (Nyssa sylvatica) (Braun, 1964).

An unusual maple-holly forest occurs along the coastal dunes at Sandy Hook, New Jersey. It is characteristically mesophytic with dominant species being American holly (Illex opaca), red maple (Acer rubrum), red cedar (Juniperus virginiana), wild black cherry (Prunas serotina), and hackberry (Celtis occidentalis) (Chrysler, 1930). It is thought to be a sand dune climax.

Coastal Vegetation

Virginia, Maryland, Delaware

The portion of Virginia, Maryland and Delaware that lies between the Atlantic Ocean and Chesapeake Bay is termed the Delmarva Peninsula. Much of the coastal zone occurs around Chesapeake and Delaware Bays with a smaller amount of shoreline of all three states directly fronting the Atlantic Ocean. Much of the Atlantic coast is protected by barrier islands. Bays and lagoons extend far inland in all three states (visuals 3 and 4).

The barrier islands are characterized by a beach on the ocean side, behind which occur low dunes. Figure II- 55 illustrates plant distributions on them. The flora associated with the dunes are primarily herbaceous. Dominant plant species are American beachgrass (Ammophila breviligulata) and its associates beach heather (Hudsonia tomentosa), Cakile endentula , Oenothera humifusa , Xanthium canadense , saltwort (Salsola Kali), seaside spurge (Euphorbia polygonifolia), knotweed (Polygonium glaucum), Panicum amarum , and Cenchrus sp., (Snow, 1902; Shreve et al., 1910). Where dunes have stabilized, the herbaceous flora is replaced by a perennial flora (Figure II- 55). Characteristic

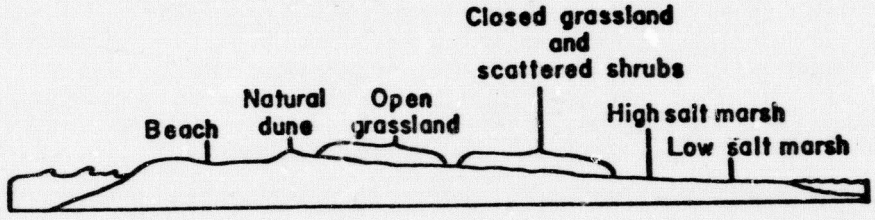

Figure II - 55. Cross Section of a Natural Barrier Beach -- (Dolan et al. 1973 in Halverson and Dawson, 1973)

species are (Lechia minor), false indigo (Baptisia tinctoria), wax myrtle (Myrica cerifera), groundsel-bush (Baccharis halimifolia), shining sumac (Rhus copallina), and Disopyros virginiana . Woodland communities may also exist behind the dunes. Common species include red cedar (Juniperus virginiana), pitch pine (Pinus rigida), southern red oak (Quercus falcata), post oak (Q. stellata), persimmon (Diospyros virginiana), and Celtis spp. (species of hackberry).

A marsh community occurs on the landward side of barrier islands, around most bays, lagoons, and lines most rivers. Generally, the more extensive the shoreline, the more extensive is the marshland. Good examples are Chesapeake and Delaware Bays. The transition from salt to freshwater marsh is not always easy to define. It can be seen, in some cases, along open waters and rivers emptying into bays.

Wetlands have been defined as the land lying between Mean Low Water and an elevation above Mean Low Water equal to 1.5 times the mean tidal range. This definition was derived from observations of the minimum elevation of the saltbush line above mean low water (Johnson, 1974).

In Atlantic tidewater Virginia, in the Lynnhaven and Rudee Inlet areas the two dominant forms of saltbush are the marsh alder Iva frutescens, and the groundsel tree Baccharis halimifolia, with the groundsel tree found more predominantly in the higher elevations. The most common forms of vegetation found in tidal wetlands of this area are the saltgrasses: saltmarsh cordgrass (Spartina alteriflora), salt meadow hay (Spartina patens), and saltgrass (Distichlis spicula) (Johnson, 1974).

According to many authors, the most important rooted aquatic plant in the Mid-Atlantic coastal area is Zostera marina or eelgrass. It is the dominant vegetation of the soft bottoms of the intertidal zone and is also found on firm sand and sand-gravel substrates. Plant distribution and abundance are affected by salinity, turbidity, wind and wave action, temperatures, eutrophication and encroachment by other vegetation (Lippson, 1973).

Zostera is especially noted for the diversity of epiphytic algae and animals that grow upon it. Odum (1974) states that the eelgrass system is one of the richest in terms of variety and abundance of life in the sea. It appears that a very large number of animal forms have adapted in interrelated ways to the various types of microhabitats that an eelgrass system presents.

For example, Martin, Zin and Nelson (1961) emphasize the importance of eelgrass to waterfowl by listing twelve species which utilize portions of the eelgrass as food. To further emphasize this dependence, it should be noted that after 90-99 percent of the

Atlantic eelgrass beds were destroyed by an epidemic in 1931, sea brant, Canada goose and black duck populations suffered considerably (sea brant numbers fell 80 percent by 1934; Moffitt and Cotton, 1941).

The two dominant submerged aquatic species growing in Chincoteague Bay, Maryland are Zostera marine (eelgrass) and Ruppia maritima (widgeon grass) (Martin, et al., 1951). There are healthy stands of aquatic vetetation along the eastern shore of Chincoteague Bay. This vegetation supports large numbers of indigenous and migratory wildlife, including ducks, geese and finfish (Anderson, 1970). Productivity in parts of Chincoteague Bay is rather low compared to that of the Patuxent River, Maryland (250 gms/m^2 as compared to 800 gms/m^2) (Anderson, 1970).

According to Anderson (1973) the status of submerged vascular plants in the Chesapeake Bay may be summarized as follows:

(1) Most of near shore waters of tidal estuaries of the Bay still support relatively healthy plant populations. This is particularly true of eastern shore tributaries such as the Choptank, Nanticoke, and Chester Rivers. The western shore of the Patuxent is also highly productive.

(2) The eastern shore from the Bay Bridge to Pocomoke Sound is highly productive, particularly in the shallow waters around islands such as Bloodsworth and Smith.

It should be noted, however, that Hurricane Agnes in 1972 did much damage to plant associations from which the Bay has still not recovered. This is because the reproductive potential of much of the vegetation which is dependent upon extensive rhizome systems shallowly buried in the bottom muds was heavily silted over as a result of the hurricane.

Distribution of the vegetation is dependent upon salinity tolerances. The following tolerances for certain species have been listed by Anderson, 1973.

Species	Salinity	Common Name
C. demersum	fresh water only	coontail
V. americana	fresh water only	wild celery
P. crispus	fresh to 5.0 ppt.	
Z. palustris	fresh to 5.0 ppt.	horned pondweed
E. canadensis	fresh to 10.0 ppt.	waterweed
M. specatum	fresh to 20.0 ppt.	milfoil
N. flexilis	5.0 to ? ppt.	
P. perfoliatus	5.0 to 25 ppt.	redhead grass
R. maritima	5.0 to 40 ppt.	widgeon grass
Z. marina	25 to 35 ppt.	eelgrass

All species prefer soft bottom muds with Z. marina apparently restricted to rich muds. All are found in 0.5 to 3 meters of water, depending on water turbidity.

Metomkin Island through Smith Island: Barrier Islands, Virginia

The Virginia barrier islands from Metomkin Island through Smith Island extend about 50 miles along the ocean affronting the Eastern Shore of Virginia (McCaffrey, 1975). The sixteen islands of the group of three major island complexes extend from about ten miles south of Assateague National Seashore to the north entrance of the Chesapeake Bay Bridge Tunnel.

A wide variety of plant communities is represented on the islands including frequently overwashed, sparsely vegetated sand flats, dense grasslands, shrub thickets, upland forests of pine and hardwood species, brackish, fresh and tidal salt marshes (McCaffrey, 1975).

The islands are generally low and sandy. A beach varying from about 50 feet wide on some of the more eroded places to 1800 feet wide on accreting sections fronts the ocean and inlets of all islands. A natural foredune, one to six feet tall, separates the beach from a grassland community. Behind this is usually a thicket and in some cases a forest. Brackish and fresh marshes are located in the interior of some islands. Vast salt marshes extend behind all islands. No papers on ecological relationships or in saltmarsh characteristics and productivity of these islands is currently in the literature (McCaffrey, 1975). The botanical characteristics of the 16 barrier islands are given in Table II-60.

Table II - 60 . Botanical characteristics of sixteen Virginia coastal Islands. (McCaffrey, 1975)

Island	Characteristics
1. Metomkin	Narrow; overwash and inlet influenced
2. Cedar	(north end): Juniper - poison ivy thicket (south end): Narrow; overwash influenced
3. Parramore	Pine and hardwood forest; fresh marshes (cattail); extensive inland brackish marshes; interior open dune thicket complex
4. Revel	Pine-hardwood forest (similar to that of Parramore); northernmost island with yaupon
5. "Crescent"	Recently formed; overwash influenced
6. Chimney Pole Marsh	Marsh island with salt pond and grassland sections
7. Hog	(north end): Salt flats; accreting beach; dense, tall wax myrtle thicket; dune gressland complex; open dunes tall thicket complex (south end): Erosion and overwash influenced
8. Rogue:	Marsh island with pond and dense grassland
9. Cobb	Dense, mesic grassland (salt meadow cordgrass) with xeric dune ridges
10. Little Cobb	Erosion and overwash influenced
11. Wreck	Dense grassland and dunes (American beachgrass)
12. Ship Shoal	Marsh island (north end): Overwash influenced (south end): Dense mesic grassland (salt meadow cordgrass)
13. Godwin	Marsh island
14. Myrtle	Dense foredune-grassland (American beachgrass)
15. Mink	Marsh island; high area of dense grassland (salt meadow cordgrass)
16. Smith	(north end): Narrow; overwash and inlet influenced (south end): Wooded dune redges alternating with brackish marshes; hardwood forest different from that on Parramore Island; only island with oaks, northernmost island with live oak; juniper is uncommon

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Assateague Island

Assateague Island, which is located north of the Metomkin-Smith Island Chain, is a long sand bar up to three miles wide and 50 miles long. Vegetation on the island was described by Higgens, et al., 1971. Vegetation on the island is similar to that of other Atlantic barrier islands and may be divided into four zones: the dune herbaceous zone, the shrub zone, the arborescent zone, and the marsh herbaceous zone. The dune herbaceous zone is made up of beach with 1 percent plant cover, usually Chaile edentula; dunegrass with a 20 percent cover and with the dominant, American beechgrass Ammophila brevilugulata associated with Spartins patens. A dungrass-shrub transition zone is continuous along the island behind the dunegrass community. Herbaceous plant cover is 60-70% while shrub cover is 20-30% of the total.

The second zone, the shrub zone, is divided into xeric- and mesic-shrub communities. The xeric shrub community runs the length of the island over secondary dunes when elevations vary from 1 to 3 meters. Cover ranges from 80% in lowlying dune areas to 30% or less in higher areas. The mesic-shrub community is interspersed with the xeric shrubs in very low areas. This shrub cover varies from 90-100% and forms a dense thicket while the herbaceous cover varies from 10-80% including dense seedlings of the dominant shrubs. Hudsonia dunes are interspersed within the xeric-community in flat open dune ridges.

The third zone, an arborescent zone is made up of pine woodlands and pine-deciduous mixed woodland. The fourth zone, a marsh herbaceous zone, is comprised of a saltmarsh covering the bayside of Assateague. Spartina patens is the dominant species and lines the entire bayside length of the island with few exceptions. Herbaceous cover is 100% and forms an outline with the low and high

marsh. Salinities vary from about 23°/00 on the low marsh to up to 30°/oo in the high marsh. Fresh marsh occurs in the island complex when the surface approaches the water table. Herbaceous species provide 100% cover in these marshes. There are numerous variations of fresh marshes which support a population of waterfowl and wild ponies.

Chincoteague Bay

A productivity study of the Chincoteague Bay salt marshes was performed by the National Resource Institute of the University of Maryland, and indicated that the marsh is considered a "high marsh" not daily flooded by lunar tides, but by spring tides and floods. Thus a hypersaline environment can develop during dry periods. However, a series of "low" regularly flooded marshes occur near the inlets to Chincoteague Bay.

The relatively high productivity of the "high" marshes of 713 gm/m^2 compares favorably with the world average of wheat production (344 gm/m^2) and sugar beet production (765 gm/m^2) as cited by Odum (1959) (Keefe, 1970). In a year the marshes produced 39.0 x 10^6 kg of organic material. This organic material is transported to the bay floor by flooding and supports a rich growth of bacteria and detritus feeders in addition to supporting herbivores such as insects, waterfowl, and ponies, while alive.

In these marshes, saltmarsh cordgrass predominates, growing in nearly pure stands throughout the area. Other common species, growing in scattered patches, include saltmeadow cordgrass,

saltgrass and hightide bush (Lippson, 1973). A summary of saltmarsh plant communities described in Maryland and Virginia may be found in Table II-61.

Chesapeake Bay

The Chesapeake Bay region has a greater diversity of habitats because it has various types of marshlands. Indeed, Chincoteague Bay has been considered by some to be one of the five types of Chesapeake Bay marsh (Lippson, 1973). The five types of marsh listed by Lippson (on whose work much of this section is based) include estuarine river marshes, fresh estuarine bay marshes, brackish estuarine bay marshes, salt estuarine bay marshes, and coastal embayed marshes (Chincoteague).

Estuarine river marshes have developed where tidewaters extend inland along the valley floor of tributary streams. The largest in Maryland, along the Nanticoke River, is 2 miles wide in some places. Most large tributaries harbor such marshes while small marshes are found along numerous small tidal streams. The most common vegetation species found include pickerelweed and yellow waterlily, river bulrush, rosemallow, phragmites and wildrice in the fresh areas, and big cordgrass, narrowleaf cattail, olney three-square, rosemallow, and phragmites in the brackish sections.

Fresh estuarine bay marshes have developed on broad, shallow estuarine flats that are flooded by fresh or slightly brackish tidewaters. Major species include olney three-square, narrowleaf cattail, common three-square, dwarf spike rush, and white waterlily.

Table II-61 . Salt marsh plant communties described in Maryland and Virginia (Higman, 1972)

Habitat	Maryland Communities (from Shreve, 9)	Virginia Communities (from Marsh, 11)
HIGH SALINITY		
Intertidal zone (lower)	*Spartina alterniflora* dominant, often pure	Same
Intertidal zone (higher)	*Spartina alterniflora* still dominant, associated on the Eastern Shore with *Salicornia herbacea, Spergularia marina, Atriplex patula,* & *Aster tenuifolius*; on the Western Shore with *Acnida cannabina, Limonium carolinianum, Pluchea camphorata,* & *Solidago sempervirens*	*Spartina alterniflora* dominant, decreases in height as elevation rises and substrate becomes sandier. Associated species not listed.
Above mean high tide (flooded by spring tide)	*Spartina patens* & *Distichlis spicata* dominate; common associates are *Aster tenuifolius, Aster subulatus, Juncus gerardi, Gerardia maritima, Pluchea camphorata,* & *Pluchea foetida*	*Spartina patens* & *Distichlis spicata* dominate lower elevations; *Juncus roemerianus* may form nearly pure stands at higher elevations. Common associates are *Salicornia* sp., *Borrichia frutescens, Sabatia stellaris,* & *Limonium nashii*
Flooded only by storm tide	Not distinguished	*Spartina patens*, scattered *Iva frutescens* & *Baccharis halimifolia*
BRACKISH		
Intertidal zone	*Iva frutescens, Typha angustifolia, Spartina cynosuroides,* or *Scirpus olneyi* dominant; associates include *Scirpus robustus, Scirpus americanus, Zizania aquatica*	*Spartina alterniflora* dominant (moderate salinity) or *Typha angustifolia* & *Peltandra virginica* (low salinity); various assoc.
Above mean high tide	Vegetation similar to high salinity marsh, plus varied associates: *Hibiscus palustris, Eryngium virginianum, Phragmites communis*, etc. (*Juncus gerardi* & *Pluchea foetida* are absent)	Vegetation similar to high salinity marsh, plus new species. *Fimbristylis* sp., *Pluchea purpurascens, Atriplex patula, Aster tenuifolius* (*Phragmites* rare)
Flooded only by storm tide	*Baccharis halimifolia, Panicum virgatum, Cuscuta* sp., *Strophostyles umbellata*, most species of high salinity marsh	Vegetation similar to high salinity marsh, plus *Eupatorium serotinum, Cassia fasciculata, Lespedeza capitata*

Brackish estuarine bay marshes occur in areas formed by a complex mosaic of ponds, creeks and marshes. Species found include big cordgrass, hightide bush, saltmeadow cordgrass, saltmarsh cordgrass, olney three-square and saltgrass.

Salt estuarine bay marshes occur in lower Maryland bay waters characterized by high salinity and narrow tidal fluctuations. Species include saltmeadow cordgrass, saltmarsh cordgrass, saltmarsh bullrush, saltgrass, and hightide bush.

The State of Maryland (1965) estimated that there were 457,000 acres of salt and fresh marsh and swamp in Maryland which accounted for 7.3 percent of all Maryland land for that year. In addition 337,000 acres of this marshland was found in the eastern shore counties of Dorchester, Wicomico, Worcester, and Somerset. Approximately half this acreage (158,000) was salt marsh (O'Donnell, 1965).

Both fish and wildlife utilize the Chesapeake Bay wetlands during parts of their life histories. Fish may use the wetlands for spawning or as nursery grounds for juvenile fish. Adults utilize the area for feeding. Usage may be seasonal, dependent upon salinities and temperatures of water and the particular niche of the fish species. A survey sample of fishery resource usage and

abundance in irregularly flooded saltmarshes of the Chesapeake Bay is given in Table II- 62. According to Metzgar (1973), studies show that 20 species use saltmarsh for spawning, 31 species use it for nursery grounds, and 32 species of adults use irregularly flooded saltmarshes for feeding. Seasonal usage varies from a summer high of 34 species to a winter low of 18 species.

Wildlife utilize the saltmarsh for food and shelter. Geese and muskrat eat rootstocks of Spartina and Scirpus sp. Ducks eat the seeds of Distichilis and geese eat branches of Salicornia.

Stems of Spartina are used for housing by muskrats; the shoveller and cinnamon teal use Distichilis and Elocharis for nesting material. A more complete list of wildlife uses of the saltmarsh is given in Table II-63 (Higman, 1972).

Approximately 22 percent (3,783,780 acres) of the Chesapeake Bay area is classified as open water, 71 percent (12,269,410 acres) as uplands and 7 percent (1,144,850 acres) as wetlands (U.S. Army Corps of Engineers, 1973) (Table II-64). There are approximately 250,000 acres of wetlands in the State of Virginia along the tributaries of the Chesapeake Bay and the Bay itself (Dawes, personal communication)[1]. An estimate of acreages of Maryland's wetlands by the State of Maryland is included in Table II-65.

[1] George Dawes, Wetlands Research Section, Virginia Institute of Marine Sciences, Gloucester Point, Virginia, personal communication, March 1976.

Table II-62. Survey sample of fishery usage and abundance in irregularly flooded saltmarshes (Type 17) or nearby waters of Dorchester County, Maryland. (Metzgar, 1973)

Fish species present		Useage			Season of Useage				Abundance		
Scientific Name	Common Name	Spawning	Nursery	Adult Feeding	Spring	Summer	Fall	Winter	High	Moderate	Low
*Petromyzon marinus	sea lamprey	"									
Carcharhinus leucas	bull shark			"							
Carcharhinus milberti	sandbar shark			"		"					
Sphyrna zygaena	hammerhead shark			"		"					
Raja eglanteria	clearnose skate			"		"					
Rhinoptera bonasus	cownose ray			"		"					
*Acipenser oxyrhynchus	Atlantic sturgeon	"			"				"		
*Alosa aestivalis	blueback herring	"			"				"		
*Alosa mediocris	hickory shad	"			"				"		
*Alosa pseudoharengus	alewife	"			"				"		
*Alosa sapidissima	American(white) shad	"			"				"		
Brevoortia tyrannus	Atlantic menhaden		"	"	"	"	"		"		
Dorosoma cepedianum	gizzard shad		"	"		"	"				
Anchoa mitchilli	bay anchovy	"	"	"	"	"	"	"	"		"
Cyprinus carpio	Carp		"	"		"	"	"			"
Notropis hudsonius	spottail shiner			"			"	"			"
Ictalurus catus	white catfish			"			"	"			"
Anguilla rostrata	American eel		"	"	"	"	"		"		"
Strongylura marina	Atlantic needlefish	"	"	"	"	"	"	"	"		
Hyporhamphus unifasciatus	halfbeak		"	"		"	"	"			
Cyprinodon variegatus	sheepshead minnow		"	"		"	"	"			
Fundulus heteroclitus	mummichog	"	"	"	"	"	"	"	"		
Fundulus majalis	striped killifish	"	"	"	"	"	"	"	"		
Lucania parva	rainwater killifish	"	"	"	"	"	"	"	"		
Syngnathus fuscus	northern pipefish	"	"	"	"	"	"	"	"		
*Roccus americanus	white perch	"	"	"	"	"	"	"	"		
*Roccus saxatilis	striped bass	"	"	"	"	"	"	"	"		
Bairdiella chrysura	mademoiselle		"	"		"	"	"			
Cynoscion regalis	greytrout (weakfish)		"	"		"	"			"	
Cynoscion nebulosus	spotted seatrout		"	"		"	"				"
Pomatomus saltatrix	bluefish		"	"		"	"				"
Leiostomus xanthurus	spot		"	"		"	"		"		
Micropogon undulatus	Atlantic croaker		"	"		"	"		"		
Pogonias cromis	black drum		"	"		"	"				"
Sciaenops ocellata	channel bass(red drum)		"	"		"	"			"	
Chasmodes bosquianus	striped blenny	"	"	"	"	"	"	"			"
Peprilus alepidotus	butterfish (Southern harvest)		"			"					
Menidia menidia	Atlantic silverside	"	"	"	"	"	"				"
Paralichthys dentatus	summer flounder		"			"					"
Pseudopleuronectes americanus	winter flounder		"				"	"			"
Trinectes maculatus	hog choker	"	"	"	"	"	"	"	"	"	
Gobiesox strumosus	clingfish (skilletfish)	"	"	"	"	"	"	"			
Opsanus tau	oyster toadfish	"	"	"	"	"	"	"			"
Spharoides maculatus	northern puffer		"							"	
	Total	20	31	32	24	34	30	18	21	4	12

*Adults present during spawning migration, but not used as a spawning ground per se.

Table II-63 Utilization of salt marsh plants by wildlife. (Higman, 1972)

Plant Species	Utilization	
	Food	Shelter
Spartina alterniflora *Spartina cynosuroides* *Scirpus* spp. *Cyperus* spp.	Seeds eaten by ducks & shore birds (*Spartina* seeds important only to black duck). Rootstocks eaten by geese & muskrat.	Dense stands shelter many birds; stems are used for muskrat houses.
Typha angustifolia	Tubers important to geese & muskrats. Not used by ducks.	Nest cover for blackbirds & marsh wrens.
Distichlis spicata *Elocharis* spp.	Seeds & rootstocks eaten by ducks.	Nest cover for ducks, esp. shoveller & cinnamon teal.
Salicornia europaea	Branches eaten by geese, seeds by ducks.	
Acnida cannabina *Hibiscus palustris* *Juncus* spp.	Seeds eaten by ducks. Roots of *Juncus* eaten sparingly by muskrats.	*Hibiscus* used moderately by red-winged blackbirds as nest site.
Iva frutescens *Baccharis halimifolia*		Favorite nest cover of red-winged blackbird, also boat-tailed grackles.
Panicum virgatum		Moderate use by red-winged blackbird.

Table II-64.

SUMMARY OF WETLAND WILDLIFE HABITAT
WETLAND (ACRES)
(US Army Corps of Engineers, 1973)

Basin	Coastal Open Fresh Water	Coastal Saline	Coastal Fresh	Inland Fresh	Sounds and Bays	Total Wetlands
Chesapeake Bay	29,357	361,785	341,985	271,471	2,284,928	3,289,526
James River Basin	43,150	9,874	17,739	35,621	61,000	167,384
Rappahannock-York River Basins	19,500	1,091	33,766	38,650	919,000	1,012,007
Potomac River Basin	4,025	2,716	17,872	12,278	422,821	459,712
TOTALS	96,032	375,466	411,362	358,020	3,687,749	4,928,629
Delaware	2,908	88,800	69,000	3,200	21,400	185,308
Maryland	924	157,092	69,883	73,354	1,651,699	1,952,952
Virginia	92,900	129,574	77,243	281,466	2,014,650	2,595,133

*Based on ''Wetlands of the United States'', 1956, Fish and Wildlife Service Circular 39; ''Delaware Wetland Study'' 1959, 1969, 1970, 1971; ''Wetlands in Maryland'' 1968; ''Survey and Analysis of Changes Effected by Man on Tidal Wetlands of Va. 1955-1969; ''Coastal Wetlands of Virginia'' 1969.

Table II-65. Summary of Maryland wetland habitat inventory by survey regions in acres. (Metzgar, 1973)

Name of wetland Name of Wetland	Central and Western	Upper Chesapeake Bay	Western Shore	Eastern Shore	Lower Eastern Shore	Total Inventoried Acreage
Seasonally flooded or flat	-	-	10	-	-	10
Inland fresh meadow	84	33	33	702	-	852
Inland shallow fresh marsh	-	-	15	736	-	751
Inland open fresh water	239	352	1,378	856	1,327	4,152
Shrub swamp	456	310	804	833	3,961	6,364
Wooded swamp	878	757	13,960	6,173	58,919	80,867
Bogs	791	-	-	-	-	791
Coastal shallow fresh marsh	-	15,674	15,573	12,308	29,717	73,272
Coastal deep fresh marsh	-	-	162	46	-	208
Coastal open fresh water	-	-	418	604	-	1,022
Coastal salt meadow	-	-	3,980	10,475	66,300	80,755
Irregularly flooded salt marsh	-	-	-	1,442	66,269	67,711
Regularly flooded salt marsh	-	-	-	348	14,266	14,614
Inventoried Acreage	2,448	17,126	36,333	34,523	240,759	331,189

Wetlands may be divided into coastal saline, coastal fresh, and inland fresh. Coastal saline marshes include salt marshes, irregularly flooded salt marshes (as Chincoteague Bay), and regularly flooded salt marshes. These represent 33 percent of wetlands in the Chesapeake Bay area. It is said that because of the physiological mechanisms necessary to endure high salinities, anerobic muds and periodic tidal innundation, saltmarsh communities are characterized by a limited diversity of plant species. The various marsh types included in this wetland category vary in productive capabilities, and it is generally believed that saltmarshes have a greater primary production than any other land unit. While they are not used directly by man in agriculture, the marshes are of extremely high quality as nursery areas for both sport and commercial fishes and various types of wildlife such as muskrats, deer and waterfowl.

Delaware

There are 106,000 acres of tidal wetlands in Delaware (Street, personal communication)[1]. Marshes in Delaware, as marshes in Maryland, vary from saltmarsh to fresh marsh for each tributary of Delaware Bay or ocean front. While an analysis has not been made, to our knowledge, which characterizes the distribution of individual marsh plants in Delaware, a series of 320 maps are

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[1] John Street, personal communication. Delaware Department of Natural Resources and Environmental Control, Water Resources Section. Dover. March 1976.

available from the Delaware Department of Natural Resources and Environmental Control for $3.00 each. A partial listing of Delaware marsh vegetation follows in Table II-66 from Lesser (1965).

A study of the diatoms and edaphic algae of Canary Creek, Delaware gives an estimate of productivity at the base of the food chain for this marsh. Over 100 species of diatoms were found living near the surface of Canary Creek, north of Lewes, Delaware. The tall (5 feet high) Spartina alterniflora, bare bank dwarf (1 foot) Spartina alterniflora, Distichilis spicata, and panne each had its own recognizable diatom organization (Sullivan, 1971).

The annual gross production of algae in Canary Creek was estimated to be 1400 lbs/acre/year or 160 gm dry matter/m^2/year of which much occurs when the grasses are dormant. Much of the algae enters the grazing pathway in creeks and bays (Daiber, 1971).

Table II-67 indicates the net production and maximum standing crop of salt marshes in selected Mid-Atlantic areas.

Table II-66. Vegetation observed on the impoundment, dike and creek surrounding marsh land at Little Creek, Delaware. (Lesser 1965)

Family and Scientific Name 1/	Common Name 2/
OSMUNDACEAE	
Osmunda regalis	Royal fern
TYPHACEAE	
Typha latifolia	Common cattail
T. angustifolia	Narrowleaf cattail
T. glauca	Blue cattail
T. domingensis	Tropical cattail
ZOSTERACEAE	
Potamogeton pusillus	Pondweed
Ruppia maritima	Widgeongrass
ALISMATACEAE	
Alisma triviale	Waterplantain
Sagittaria latifolia	Arrowhead
GRAMINEAE	
Distichlis spicata	Saltgrass
Phragmites communis	Reed
Lolicum perenne (planted)	Perennial Rye-grass
Hordeum jubatum	Foxtail barley
Spartina pectinata	Prairie cordgrass
S. cynosuroides	Big cordgrass
S. alterniflora	Saltmarsh cordgrass
S. patens	Saltmeadow cordgrass
Leersia oryzoides	Rice cutgrass
Zizania aquatica (planted)	Wildrice
Panicum dichotomiflorum	Fall panicum
P. virgatum	Switchgrass
Echinochloa crusgalli - var. frumentacea (planted)	Japanese millet
E. walteri	Wild millet
Setaria geniculata	Pigeongrass
S. magna	Giant setaria
CYPERACEAE	
Cyperus strigosus	Cyperus
C. ordoratus	Cyperus
Eleocharis parvula	Dwarf spikerush
E. obtusa	Spikerush
E. palustris	Common spikerush
Scirpus americanus	Common three-square
Scirpus Olneyi	Olney's three-square
S. validus	Softstem bulrush
S. robustus	Saltmarsh bulrush
S. cyperinus	Woolgrass
Carex vulpinoidea	Sedge
C. tribuloides	Sedge
C. lurida	Sedge
ARACEAE	
Peltandra virginica	Peltandra
LEMNACEAE	
Spirodela polyrhiza	Big duckweed
Lemna minor	Duckweed
JUNCACEAE	
Juncus bufonius	Rush
J. Gerardi	Blackrush
J. Dudleyi	Rush
J. effusus	Common rush
J. acuminatus	Rush
IRIDACEAE	
Iris pseudacorus	Iris
Sisyrinchium atlanticum	Blue-eyed-grass
SALTCACEAE	
Salix nigra	Black willow
MYRICACEAE	
Myrica pensylvanica	Bayberry
LENTIBULARIACEAE	
Utricularia sp.	Bladderwort
RUBIACEAE	
Galium tinctorium	Bedstraw
Cephalanthus occidentalis	Buttonbush
CAPRIFOLIACEAE	
Viburnum dentatum	Southern Arrow-wood
COMPOSITAE	
Solidago sempervirens	Seaside goldenrod
Aster subulatus	Aster
Baccharis halimifolia	Groundsel bush
Iva frutescens	Hightide-bush
Bidens cernua	Beggartick
Pluchea camphorata	Saltmarsh fleabane

Dominant Species	Net Production or Standing Crop g (dry) m^{-2} yr^{-1}	Method	Locale	Source
Spartina alterniflora	1,570	a	Georgia	Smalley (1959)
	3,000	c	Georgia	Odum (1959)
	329-1,296	a	North Carolina	Stroud and Cooper (1969)
	650	a	North Carolina	Williams & Murdoch (1969)
	1,332	b	Virginia	Wass and Wright (1969)
	427-558	b	Virginia & Maryland	This study
	445	a	Delaware	Morgan (1961)
	300	b	New Jersey	Good (1965)
S. cynosuroides	1,456	b	Virginia	Wass and Wright (1969)
S. townsendii	700-1,060	b	England	Ranwell (1961, 1964)
S. patens	1,296	a	North Carolina	Waits (1967)
	805	b	Virginia	Wass and Wright (1969)
	993	b	Long Island, N. Y.	Harper (1918)
S. alterniflora with *Distichlis spicata*	518	b	Virginia and Maryland	This study
S. patens with *D. spicata* and *Scirpus robustus*	1,334	a	North Carolina	Waits (1967)
D. spicata	360	b	Virginia	Wass and Wright (1969)

Explanation of Method Column

a = Production estimate took into account material that was produced during the growing season, but was removed before the time of peak standing crop.

b = Maximum standing crop without correction for material that was removed before sampling.

c = Method was not specified in the text of the paper.

Table II-67. Net production and maximum standing crop of salt marshes in certain mid-Atlantic and south-Atlantic states. (Keefe and Boynton, 1973)

New Jersey

The vegetation of coastal New Jersey has been described by Harshberger (1900). The coastal areas of New Jersey are shown in Figure II-56. According to Halvorson and Dawson (1973), he lists the following vegetation types: beach formation, dune formation, thicket formation, marsh-dune formation, salt marsh formation, bay dune formation, bay beach formation, and bay water formation. Some components are as follows:

Beach Flora:	Cakile edentula	Dune Grass
	Arenaria peploides	Sand wort
	Salsola kali	Salt wort
	Euphorbia polygonifolia	Seaside Spurge
	Centrus spp.	
	Oenothera humifusa	
	Gerardia maritima	
	Solidago sempervirons	Seaside Goldenrod
	Strophostyles helvola	
Dune Flora: (Crest and lee)	Ammophila breviligulata	American Beachgrass
	Lathyrus japonicus	Beach Pea
	Solidago sempervirons	Seaside Goldenrod
	Myrica cerifera	Wor Myrtle
	Baccharis halimifolia	Groundsel Bush
	Rhus copallina	Shining Sumac
	Panicum virgatum	Switch Grass
	Strophostyles helvola	
	Hudsonia tomentosa	Beach Heathen
	Scirpus spp.	Bullrushes
	Gerardia maritima	
	Vaccinium spp.	Swamp Bush
	Rosa spp.	Rose
	Rhus radicans	Poison Ivy
	Juniperus virginiana	Red Cedar
	Pinus rigida	Pitch Pine
	Ilex opaca	American Holly
	Quercus phellos	Willow Oak
	Q. ilicifolia	Scruh Oak

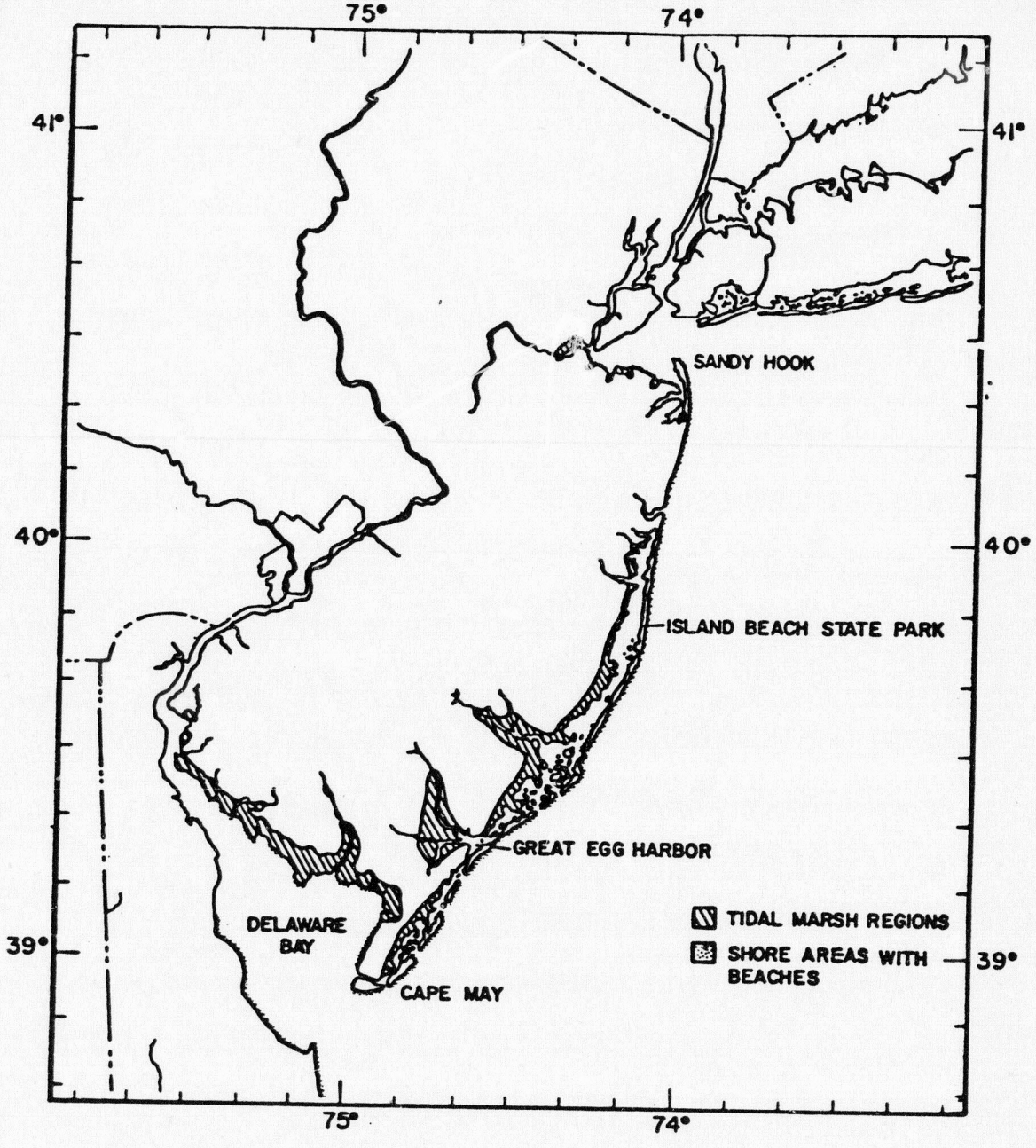

Figure II- 56 Coastal Areas of New Jersey
(Halvorson and Dawson, 1973)

Marsh: (Fresh Water)	*Sagittaria latifolia*	Arrowhead
	Ptilimnium capillaceum	
	Polygonum hydropiperoides	
	Hypericum spp.	St. Johns Wort
	Teucrium canadense	American Germander
	Phragmites spp.	Common Reed Grass
	Spartina cynosuroides	
	Juncus spp.	Rush
	Panicum spp.	Switch Grass
	Spiranthes cernua	Nodding Ladies-Tresses
	Typha spp.	Cat-tail
	Peltandra virginium	Arrow-Arum
	Pontedaria cordats	Pickerel-Weed
Protected Thickets:	*Juniperus virginiana*	Red Cedar
	Ilex opaca	American Holly
	Iva frutescens	Marsh Alder
	Pinus rigida	Pitch Pine
	Rhus copallina	Shining Sumac
	Diospyros virginiana	Common Persimmon
	Vitis spp.	Grape
	Rhus radicans	Poison Ivy
	Prunus maritima	Beach Plum
Marsh: (Salt Water)	*Spartina alterniflora*	Salt Marsh Cordgrass
	S. patens	Salt Meadow Cordgrass
	Juncus gerardi	Rush
	J. scirpoides	Rush
	Salicornia spp.	Glass wort
	Liminium carolinianum	Sea-Lavender
	Baccharis halinifolia	Groundsel-Bush
	Spergularia marina	
	Distichlis spicata	Salt grass
	Sabatia stellaris	
	Ruppia maritima	Widgeon Grass
	Zostera marina	
	Iva spp.	

Martin (1959), in a more recent and intensive study, described the distribution of communities found on barrier islands of New Jersey (Table II-68.

Table II- 68.

THE INTERRELATION OF TOPOGRAPHY AND COMMUNITY TYPES ON ISLAND BEACH STATE PARK, NEW JERSEY--After Martin (1959) (Halvorson and Dawson, 1973)

Community Types	Primary Dunes		Secondary Dunes			Bayshore	
	Foredunes	Backdunes	Foredunes	Hollows	Backdunes	Inner	Outer
Ammophila	———		———				
Hudsonia		———	———				
Fresh marsh				———	———		
Salt marsh						———	
Low xeric thicket	———		———				———
Low mesic thicket		———		———	———		
Spartina-Iva savanna						———	
High mesic thicket			———	———	———	———	———
Spartina-Baccharis-Juniperus savanna					———		
Juniperus woodland			———	———	———		
Pinus woodland			———	———			

Marshes

The northern limit of salt marshland in New Jersey starts in the Newark Bay area and extends up the valleys of the Passaic and Hackensack Rivers. A huge marshland of about 18,000 acres, known as the Hackensack meadows, is located at the southern part of the Hackensack valley (Robichaud and Buell, 1973). Southward in Jersey are saltmarshes in the Raritan Bay area, particularly where streams empty into the Bay. Small areas of tidal marshland also occur on the inner side of Sandy Hook and along the shores of the Shrewsbury River.

From Bay Head southward larger areas of tide marsh occur. Around Barnegut and Tuckerton on the mainland there are large stretches of saltmarsh which continue to border the mainland coast to Cape May. From Atlantic City Southward the area of salt marshes grows wider, stretching from the coast of the mainland to the bay side of the offshore islands. Tide marshes also occur along the southern coast of New Jersey in the Delaware Bay from Cape May along the Delaware River coast to Trenton. According to Robichaud and Buell (1973), New Jersey has about 350 square miles of tidal land; 177 square miles edge the Delaware Bay, and 140 square miles are along the Atlantic coast counties of Atlantic, Burlington and Ocean.

The percent of natural marshes, muskrat impoundments, and waterfowl impoundments have been listed by the State of New Jersey (1973) for its coastal counties as shown in Table II-69. Atlantic County has the largest acreage of marshlands with 43,157 acres of natural marsh and 2,066 acres of waterfowl impoundments. Other ocean fronting counties with large acreages of natural marsh include Ocean and Cape May. Cumberland County has the largest acreage (43,018) for coastal counties on the Delaware Bay, and Salem County is second in acreage with 24,549 acres of natural marsh and 3,876 acres of muskrat impoundments.

While the Hackensack Meadowlands District extends for 19,730 acres in Hudson and Bergen Counties near New York City on the Hackensack River (State of New Jersey, 1975), much of the area is not marshland. Estimates for natural marshes for these two counties are given in Table II-69.

The biology of the marshes of New Jersey is similar to that discussed previously for the Chesapeake Bay system to the south.

Phytoplankton and zooplankton for Raritan Bay and other New Jersey waters have been discussed earlier in Section II.F.1.

Table II-69. Marsh Remaining in New Jersey Wetland Areas. (State of New Jersey, 1973).

County	Acres		
	Natural Marsh	Muskrat Impoundments	Waterfowl Impoundments
A. Atlantic Coast			
1. Bergen	2,438	--	--
2. Hudson	1,623	--	--
3. Union	0	--	--
4. Essex	0	--	--
5. Middlesex	3,374	--	--
6. Monmouth	2,021	--	--
7. Ocean	26,078	--	100
8. Burlington	7,218	--	--
9. Atlantic	43,157	--	2,066
10. Cape May	32,816	--	373
B. Delaware Bay/River			
1. Cape May	9,105	--	--
2. Cumberland	43,018	--	242
3. Salem	24,549	3,876	--
4. Gloucester	3,674	--	--
5. Camden	553	--	--
6. Burlington	1,210	--	--
7. Mercer	796	--	--

Barrier Islands

From Bay Head to Ocean City the barrier islands formation is still in early stages of development and the lagoons of Barnegat Bay, Little Egg Harbor, and Great Bay remain as open waters. From Ocean City to Cape May the barrier islands are in a later stage and marshlands are now filling up the lagoons. It is estimated that the New Jersey barrier islands are retreating toward the mainland at a rate of about 2 feet per year (Robichaud and Buell, 1973).

New York

Conard (1935) described the plant associations of central Long Island. He lists the salt marsh dominants according to area as: saltmarsh cordgrass (Spartina alterniflora); grasswort Salicornia virginica; salt grass (Distichlis spicata); saltmeadow cordgrass (Spartina patens); Spergularia marina; plantain (Plantago juncoides); Suaeda maritima ; and bulrush (Scirpus americanus). He found the beach communities dominated by dunegrass (Cakile edentula); American beachgrass (Ammophila breviligulata); and seaside goldenrod (Solidago sempervirons). In stabilized areas, beach heather (Hudsonia tomentosa); beach plum (Prunas maritima); wax myrtle (Myrica cerifera); red cedar (Juniperus virginiana); swamp rush (Vaccinium spp.); marsh alder (Iva frutescens); and pitch pine (Pinus rigida) were found to occur. Common reed grass (Phragmites communis) occurs among the shrubs in fresh water areas.

Halvorson and Dawson (1973) report that the vegetation of the south side of Long Island exposed to the Atlantic Ocean is very similar to that found in New Jersey, and the north side similar to that of the Connecticut coast.

About 15 percent of the total amount of shoal waters along southern Long Island are wetlands--marshes and meadows. This amounts to about 15 percent of 125,000 acres or 18,750 acres of wetlands (Taormina, 1976)[1].

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[1]Taormina, personal communication. New York State Department of Environmental Conservation, Stoneybrook, Long Island, New York. March, 1976.

We note here, however, that the shoal waters are used by many waterfowl and wading birds throughout the fall, winter and spring. While these animals will be discussed in the following section, the acreages of water on which they live is listed below:

Location	Acreage
Jamaica Bay	12,200
Lawrence Marshes	2,000
Hempstead	12,000
Oyster Bay	6,000
Great South Bay	64,000
Moriches Bay	11,000
Shinnecock & Quantuck Bays	10,000
Lower Bay	10,000
	125,000 acres

The value of such bay bottom per acre has been estimated by Taormina (1967)[1]. Considering an average price to the digger of clams at $7.00 per bushel, and considering them to be a renewable resource, Taormina estimates that an acre of such bay bottom to be worth $4,200 for shellfish production alone. He also estimated that an acre of bay bottom was worth $500.00 or more for wildlife habitat.

There are no well-developed barrier islands on the coast of Connecticut nor on the northern shores of Long Island. Salt marshes are confined to estuarine situations or are associated with rivers where they enter the sound. According to Niering (1961), saltmarsh cordgrass (Spartina

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[1] A. S. Taormina, The Natural Value of Wetlands. New York State Environmental Conservation, Information Leaflet No. L-152, 1976.

alterniflora borders water and is backed by saltgrass (Distichlis spicata) and salt meadow cordgrass (Spartina patens). Other species include sea lavender (Limonium carolinianum); Gerardia maritima; Aster subulatus; plantain (Plantago juncoides); saltwort (Salsola kali); and seaside goldenrod (Solidago sempervirons). Switch grass (Panicum virgatum); groundsel bush (Baccharis halimifolia); marsh alder (Iva frutescens); and common rose-mallow (Hibiscus palustris) are found in upper reaches of marshes where salinity is lower. In tidal rivers and streams cattail (Typha); reed grass (Phragmites); bulrush (Scirpus) dominate (Hill and Shearin, 1970).

Miller and Egler (1950) have also described the tidal flora of Connecticut. The sequence they describe is similar to that of Niering. Johnson and York's (1915) description of vertical distribution of a marsh is given in Table II-70.

Table II- 70.

VERTICAL DISTRIBUTION OF THE MORE COMMON LAND PLANTS OF COLD SPRING HARBOR--
After Johnson and York (1915)
(Halvorson and Dawson, 1973)

Tide Levels		Supra-Littoral Beach of Spit			Supra-Littoral Marsh		
12 Feet	Vegetation Belts	Species	Range		Species	Range	
		Ammophila breviligulata	8.3 to	12	Scirpus americanus	6.5 to	12
		Cakile edentula	8.5	11.5	Dryopteris thelypteris	8.5	12
		Solidago sempervirens	8	11.5	Juncus gerardi	7.3	8.8
		Lathyrus maritimus	10	11	Spartina patens	6.5	8.7
11 Feet		Euphorbia polygonifolia	8.5	12	Eleocharis olivacea	8.3	12
		Salsola kali	8.5	12	Scirpus robustus	6.8	8.7
		Xanthium echinatum	10	11.5	Solidago sempervirens	6.5	12
		Aster tenuifolius	9	11	Iva frutescens	7.5	8.5
		Atriplex arenaria	6.5	8.7	Aster subulatus	7.3	9
10 Feet	Supra-Littoral Belt	Rhus radicans	9	12	Hibiscus moscheutos	8	12
	8 to 12 feet	R. glabra	11	12	Gerardia maritima	8	8.7
		Polygonum scandens	9	12	Distichlis spicata	6.5	8.5
		Ailanthus glandulosa	9	12	Lysimachia terrestris	9	?
		Verbascum thapsus	9	12	Asclepias incarnata	8.3	12
		Agropyron repens	8.3	12	Agropyron repens	8.7	12
		Galium claytoni	8	12	Solaginella apus	9	12
9 Feet		Oenothera biennis	11	12	Palavacinnia lyellii	9	12
		Robinia pseudoacacia	9	12			
		Salix sp.	11.8	12			
		Polygonella articulata	10	12			
8 Feet							
		Spartina patens	6.5	8.7	Atriplex patula hastata	6	8.5
		Suaeda maritima	6.5	8	Limonium carolinianum	7.3	8.3
		Salicornia europaea	6.5	7.5	Plantago juncoides	6.3	8.3
	Upper Littoral Belt	Juncus gerardi	7.3	8.8	Scirpus nanus	6.3	8
	6.5 to 8 feet	Scirpus americanus	6.5	12	Triglochin maritima	6.3	7.5
7 Feet		S. robustus	6.8	8.7	Typha angustifolia	7.8	12

Table II-70. Continued.

Tide Levels 7 Feet	Vegetation Belts	Supra-Littoral Beach of Spit		Supra-Littoral Marsh	
		Species	Range	Species	Range
		Distichlis spicata	6.5 to 8.5		
		Salicornia ambigua	6 7.5		
6.5 Feet		Spergularia marina	7 8		
6 Feet		Spartina alterniflora			1.5 to 6.5
		Lilaeopsis lineata			5.5 to 6.5
5 Feet					
	Mid-Littoral Belt 1.5 to 6.5 feet Mid-Littoral Marsh and Mid-Littoral Rockweed Association				
3 Feet					
2 Feet					
1.5 Feet					
0 Foot--M.L.W.		Zostera marina			-3 to 1.5
		Ruppia maritima			0
	Bottom Vegetation -5 to +1.5 feet				
-1 Foot	(Lower Littoral and Sub-Littoral belts)				
-2 Feet					
-3 Feet					

The two numbers given under "range" indicate the levels (above mean low water) between which the species usually grows. The species are given in each belt in the order of prevalence.

b. Marine and Coastal Birds

Approximately 380 species of birds are listed as occurring in the Mid-Atlantic area (Heppner and Gould, 1973). They report that approximately 80 percent of them occur on a migratory basis at some time of the year. Visitations occur primarily during the migration periods in spring and fall when both the numbers of individuals and species increase (Heppner and Gould, 1973). Large populations are reported in Delaware and Maryland, with the largest percentages being waterfowl associated with Chesapeake Bay and also the refuges/marshes of the Atlantic coastline. Tables II-71 through II-73 indicate many of the species found in the area. Table II-71 gives representative birdlife of the Mid-Atlantic bight area. Tables II-72 and II-73 give shorewaders and other estuarine birds all along the Mid-Atlantic area. The latter table also gives breeding colonies of Virginia birds.

	PELAGIC OR OPEN OCEAN >5 MILES	LITTORAL OR OUTER SHORE <5 MILES	BAYS/ SOUNDS	FREQUENCY IN AREA	DATES PRESENT	PERIODS OF GREATEST ABUNDANCE AND ESTIMATED NUMBERS
Black-Capped Petrel	X			Casual	?	?
Gannet	X	X		Common, abundant migrant	Late March - Mid May Late Oct. - early Dec.	-
Red Phalarope	X	X		Common, Summer, Fall migrant	Late March-Late April, Sept.-early Nov.	5,000
Northern Phalarope	X	X	X	Rare Fall Migrant, casual Spring migrant	July - Sept.	100
Pomarine Jaeger	X	X		Uncommon, rare migrant	Early May - Mid November	100
Parasitic Jaeger	X	X		Regular migrant	Early May - Mid November	100
Long-Tailed Jaeger	X			Casual migrant	Late May - early June Early Aug. - early Sept.	-
Glaucous Gull		X	X	Uncommon, rare - regular Winter visitor	All year	100
Iceland Gull		X	X	Uncommon, regular Winter visitor	Nov. - March	Dec. - Feb. 100
Great Black-Backed Gull		X	X	Common, abundant resident & migrant	All year	Sept. 5,000
Herring Gull		X	X	Very abundant resident	All year	Dec. - Feb. 100,000
Ring-Billed Gull		X	X	Common, Abundant migrant Winter visitor	All year	Aug.-Nov. 5,000
Black-Headed Gull			X	Uncommon, rare Winter visitor, occasional Summer visitor	Nov. - late March	100
Laughing Gull		X	X	Common, abundant migrant, Summer visitor uncommon Winter visitor	All year	Late March - Mid Dec.
Bonaparte's Gull		X	X	Common, abundant migrant, Winter visitor	Oct. - May	5,000
Black-Legged Kittiwake	X	X		Uncommon, common Winter visitor	Nov. - Feb.	10,000
Gull-Billed Tern		X		Rare, irregular Spring & Fall visitor	Early June - Mid Sept.	500
Forester's Tern		X		Uncommon - common Fall migrant, Summer resident		100
Common Tern		X	X	Abundant migrant, Summer resident	May - Mid October	500
Artic Tern	X			Accidental	-	5,000
Roseate Tern		X		Uncommon, abundant Spring resident, Fall migrant	Mid May - Sept.	-
Least Tern		X		Common, abundant migrant, fairly common Summer resident	May - Mid Sept.	1,000
Royal Tern		X		Rare, Summer & Fall visitor		500
Sandwich Tern		X		Casual	July - Oct.	
Caspian Tern		X	X	Uncommon migrant, Summer resident in N.J.	Sept.	100
Black Tern		X		Uncommon occasionally abundant migrant, occasionally Summer visitor	Aug.-Sept.	-
Black Skimmer		X		Local Summer resident, common abundant, occasional Summer visitor	Late May - early Oct.	500
Razorbill Auk	X	X	X	Rare, irregular Winter visitor	Mid May - Mid Oct.	5,000
Common Murre	X	X	X	Casual		5,000
Thick-Billed Murre	X	X	X	Rare, irregular Winter visitor	Late Dec. - early March	100
Dovekie	X	X		Rare, regular Winter visitor	-	100
Black Guillemot		X		Casual, rare Winter visitor	Dec. - Feb.	100
Common Puffin		X	X	Casual, Winter visitor	Mid Nov. - early March	100
White-Tailed Tropic-Bird	X			Casual, for offshore	Nov. - March	100
Blue-Faced Booby	X			Normal & regular off Cape Hattaras	Nov. - March	100
Frigate Bird	X			Casual, off Carolinas	-	-
					-	-
					-	-
					-	-

Table II-71. Migratory waterfowl and other Marine Birds of the mid-Atlantic Bight. (Gusey, 1976)

BEST COPY AVAILABLE

	PELAGIC OR OPEN OCEAN > 5 MILES	LITTORAL OR OUTER SHORE < 5 MILES	BAYS/ SOUNDS	FREQUENCY IN AREA	DATES PRESENT	PERIODS OF GREATEST ABUNDANCE AND ESTIMATED NUMBERS
Common Loon	X		X	Common, abundant, migrant, Winter	Year-round	April, November 500
Red-throated Loon	X		X	Common, abundant, migrant, Winter	Nov., Dec., April	Nov. & April 500
Red-necked Grebe	X			Uncommon, fairly common, migrant, irregular Winter	Oct. - April	-
Horned Grebe	X		X	Common, abundant, migrant, Winter	Oct. - Dec.	100
Pied-billed Grebe			X	Fairly common, migrant, uncommon in winter	Sept. & April	1,000
Whistling Swan			X	Uncommon, Winter migrant	Nov. - March	September 100
Canada Goose			X	Abundant, migrant, Winter visitor	March - Nov.	100
Brant			X	Abundant, migrant, Winter visitor	Dec. - April	March 10,000
Mallard			X	Common, abundant, resident & migrant	All year	100,000
Black Duck			X	Abundant Fall migrant, Winter visitor Spring	All year	500 -
European Widgeon			X	Uncommon, migrant Winter visitor	Oct. - March	5,000
American Widgeon			X	Common, abundant migrant, Winter visitor	Sept. - April	100
Ring-necked Duck			X	Locally common, abundant migrant, Winter visitor	Oct. - Mid-April	5,000
Canvasback			X	Common, Winter visitor	Nov. - early April	500
Greater Scaup			X	Abundant, Winter visitor	All year	1,000
Lesser Scaup			X	Fairly common, Spring migrant, rare Winter visitor		100,000 -
Common Goldeneye	X		X	Common or abundant Winter visitor	Nov. early April	5,000
Bufflehead	X		X	Locally common, abundant Winter visitor	Mid-Oct. - April	500
Oldsquaw	X		X	Common, ocasionally abundant Winter visitor	All year	5,000
Common Eider	X		X	Common, abundant migrant, Winter visitor	Oct. - April	100,000
White-winged Scoter	X		X	Abundant migrant	Nov. - March	100,000
Surf Scoter	X		X	Common, abundant migrant	Oct. - April	100,000
Common Scoter	X		X	Common, abundant migrant	Oct. - April	100,000
Ruddy Duck			X	Common, abundant Fall migrant, Winter visitor	Oct. - March	1,000
Hooded Merganser			X	Common, abundant migrant	Oct. - April	100
Red-brested Merganser			X	Common, abundant migrant	Nov. - March	10,000
Common Merganser			X	Uncommon, Winter visitor	Nov. - April	100
American Coot			X	Common, abundant, Fall migrant, Winter visitor	All year	1,000
Fulmar	X	X		Accidental	Oct. - Jan.	100
Cory's Shearwater (North Atlantic Shearwater)	X	X		Common - abundant, late Summer & Fall visitor	July - Mid Nov.	Late Aug. - Late Oct.
Great Shearwater	X	X		Rare common Summer visitor	Late May - early Oct.	1,000
Sooty Shearwater	X	X		Casual - abundant Summer visitor	Late May - Mid Sept.	500 Peak, late May-early June
Audubon's Shearwater	X	X		?	?	500
Manx Shearwater	X			Casual	?	?
Leach's Storm Petrel	X	X		Casual, Summer & Fall visitor	Early May - early Nov.	?
Wilson's Storm-Petrel	X	X		Common - Abundant, Summer visitor	Late May - late Aug.	-
Frigate Storm-Petrel	X			Casual	?	10,000
Harcourt's Storm-Petrel	X			Casual	?	?
Bermuda Petrel	X			Accidental	?	? ?

Table TT-71 (con't) Migratory waterfowl and other Marine Birds of the mid-Atlantic Bight. (Gusey, 1976)

Table II-72 Shorewaders and other birds associated with Maryland wetlands*.
(State of Maryland, undated)

COMMON NAME:

American avocet
American bittern
Least bittern
Red-wing blackbird
Yellow-headed blackbird
Bobolink
Snow bunting
Double-crested cormorant
Fish crow
Long-billed dowitcher
Short-billed dowitcher
Dunlin
Golden eagle
Bald eagle
Cattle egret
Common egret
Snowy egret
Peregrin falcon
Gannet
Hudsonian godwit
Marbled godwit
Boat-tailed grackle
Horned grebe
Pied-billed grebe
Red-neck grebe
Black-backed gull
Heron gull
Laughing gull
Ring-billed gull
Marsh hawk
Rough-legged hawk
Black-crowned night heron
Great blue heron
Green heron
Little blue heron
Louisiana heron
Yellow-crowned night heron
Glossy ibis
White ibis
Wood ibis
Killdeer
Belted kingfisher
Black-legged kittiwake
Knot
Common loon
Red-throated loon
Osprey
Barn owl
Short-eared owl
Snowy owl
American oystercatcher
Wilson pelican
Northern phalarope
Red phalarope
Wilson's phalarope
Black rail
Clapper rail
King rail
Sora rail
Ruff
Bairds sandpiper
Least sandpiper
Pectorial sandpiper
Purple sandpiper
Semi-palmated sandpiper
Solitary sandpiper
Spotted sandpiper
Stilt sandpiper
Western sandpiper
White-rump sandpiper
Cory's shearwater
Greater shearwater
Sooty shearwater
Black skimmer
Common snipe
Ipswich sparrow
Sharp-tailed sparrow
Swamp sparrow
Seaside sparrow
Bank swallow
Tree swallow
Mute swan
Whistling swan
Black tern
Common tern
Forster's tern
Gull-billed tern
Least tern
Ruddy turnstone
Whimbrel
Willet
Long-billed marsh wren
Short-billed marsh wren
Greater yellowlegs
Lesser yellowlegs

*NOTES:

- Excludes "waterfowl" (Geese and ducks).
- Includes only those species which utilize wetland habitat on a regular or predictable basis.
- Does not include species unique ot Pocomoke swamp such as swainson or prothonotary warblers.
- Does not include species which may utilize ocean beaches at one time or another.
- Original source: Chandler Robbins, 1968.

TABLE II-73.

NUMBER OF BREEDING PAIRS OF COLONIAL AND BEACH NESTING BIRDS OF THE VIRGINIA BARRIER ISLANDS: JUNE-JULY 1975

(Williams, 1975)

	Assateague*	Wallops*	Assawoman*	Metomkin	Cedar	Dawson Shoals*	Parramore	Revel	Chimney Pole Marsh*	Sandy	Hog	Rogue	Cobb	Little Cobb	Wreck	Shipshoal	Godwin	Mink	Myrtle	Smith	Fisherman	TOTAL
GREEN HERON	-	-	-	-	-	-	-	-	-	-	-	3	-	-	10	4	-	-	-	-	-	17
LITTLE BLUE HERON	-	-	-	20	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	44	74
CATTLE EGRET	-	-	-	32	-	-	-	-	-	-	2	-	-	-	7	-	-	-	-	-	200	241
GREAT EGRET	-	-	-	32	-	-	-	-	-	-	25	-	-	-	6	6	-	-	-	-	57	126
SNOWY EGRET	-	-	-	340	-	-	-	-	-	-	55	-	-	-	25	23	-	-	-	-	153	596
LOUISIANA HERON	-	-	-	270	-	-	-	-	-	-	34	-	-	-	80	25	-	-	-	-	21	430
BLACK-CROWNED NIGHT HERON	-	-	-	8	-	-	-	-	-	-	71	-	-	-	35	2	-	-	-	-	453	569
YELLOW-CROWNED NIGHT HERON	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	8	5	23
GLOSSY IBIS	-	-	-	198	-	-	-	-	-	-	150	-	-	-	13	-	-	-	-	-	25	386
OSPREY	2	5	-	-	1	-	3	5	-	-	-	-	3	-	-	-	-	-	-	5	6	30
OYSTERCATCHER	-	a few	10	30	30	-	4	-	-	-	28	-	23	-	60	14	-	-	15	50	-	264+
PIPING PLOVER	-	few	3	7	4	-	4	-	-	-	11	-	6	-	-	2	-	-	2	-	-	39+
WILSON'S PLOVER	-	few	3	6	3	-	-	-	-	-	2	-	2	-	-	4	-	-	4	5	-	29+
WILLET	-	few	18	30	350	-	30	-	-	-	100	-	34	-	100	25	-	-	25	-	40	752+
HERRING GULL	-	-	-	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	600	660
LAUGHING GULL	-	-	-	80	-	-	-	-	50	235	-	-	-	-	1300	-	-	-	-	-	200	1865
GULL-BILLED TERN	-	-	-	360	2	4	9	-	-	-	61	-	22	150	6	275	-	-	148	78	?	965+
COMMON TERN	-	-	-	680	10	15	40	-	10	-	95	-	85	150	6	200	-	-	603	162	285	2181+
LEAST TERN	-	-	-	117	67	-	51	-	-	-	19	-	10	-	-	20	-	-	15	80	-	379
ROYAL TERN	-	-	-	1600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	800	2400
SANDWICH TERN	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5-6	8-9
CASPIAN TERN	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
BLACK SKIMMER	-	-	-	950	-	80	150	-	25	-	560	-	125	400	75	500	-	-	115	255	500	3710

* Islands not owned by the Nature Conservancy.

Habitats

A method of describing bird distribution is by their habitat. Marine and coastal bird habitats are classified into the following (TRIGOM, 1974):

Oceanic (Pelagic) - beyond the limits of the Continental Shelf

Neritic (nearshore) - from the edge of the Continental Shelf to the littoral zone

Rocky shore - rocky areas, including jetties, breakwaters, and the littoral (intertidal) zone

Beaches - sandy shore, both strand and littoral

Tidal flats - mud flats and sand bars exposed by falling tide

Upper beaches and dunes - sandy areas above high tide mark and barrier beaches and dunes

"Salt Marsh" - tidal marsh and estuary, brackish marsh, seaside salt marsh, and tidal creeks

Bay/sounds - bays, harbors, and coves

Representative birds found in these habitats are listed in TRIGOM (1974). It must be emphasized, however, that birds can and often occupy more than one habitat. Bird counts are maintained for various refuge areas by the U.S. Fish and Wildlife Service and other counts are available on a localized basis by ornithological societies such as the Audubon Society.

Waterfowl counts are collected by the U.S. Fish and Wildlife Service from accounts of various states. The USFWS bird counts for The January census 1976 and total of 1975 are included in Table II-74 The life histories of four representative species is given below.

Dabblers. The black duck Anas rubripes, breeds from Newfoundland to eastern Virginia and North Carolina, and winters from New Brunswick southward. It is commonly known in the Mid-Atlantic area as an abundant migratory and mid-winter visitor. The black duck usually nests on the ground near the water, is usually sheltered by vegetation; and lives in a depression of grass and dead leaves lined with down.

The black duck is preyed upon by crows, mammals, snakes, turtles, and man, and may fall victim to lead poisoning, oiling and hunting. Diet for the species is 75 percent vegetable, and consists of cordgrass (mainly leaves and stems), pond weeds, eelgrass, wild celery, wild rice, and grass. The animal portion of the diet (25 percent) includes shellfish, crustaceans, a few fish and fish eggs.

Table II-74. Numbers of Dabbling Ducks, Diving Ducks, Sea Ducks, Geese, Swans and Coots for January 5-10, 1976 by State (incl. totals for 1975) for Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland and Virginia (Blandin 1976)

	Rhode Island	Conn.	New York	New Jersey	Delaware	Maryland	Virginia
DABBLERS							
Mallard	325	725	6,340	18,065	22,725	25,300	14,927
Black Duck	1,798	7,372	20,747	92,705	16,660	23,100	21,905
Gadwall	-	-	-	-	160	400	4,700
Wigeon	-	360	355	6,400	167	700	10,751
G.W. Teal	-	-	-	1,450	250	1,700	2,000
Shoveller	-	-	11	900	325	100	1,150
Pintail	-	-	2	1,700	3,780	700	7,825
TOTAL 1976	2,123	8,317	27,455	121,230	44,067	52,000	63,258
TOTAL 1975	1,492	3,057	26,282	112,380	20,970	37,700	52,300
% Change	+42.2	+172.0	+4.4	+7.8	+110.1	+37.9	+20.9
DIVING DUCKS							
Scaup	19,872	18,370	37,103	65,920	1,970	13,200	1,477
Ringneck	-	-	-	50	7	100	-
Goldeneye	236	442	9,018	28,600	220	2,000	445
Bufflehead	35	28	2,246	32,900	250	10,800	4,674
Rudder	-	-	1	4,800	1,812	3,200	1,503
Redhead	-	-	7,270	380	5	7,500	2,745
Canvassback	785	1,190	13,830	28,765	1,025	49,300	10,628
TOTAL 1976	21,333	19,625	69,468	161,415	5,289	86,100	24,772
TOTAL 1975	35,538	7,400	96,470	137,270	9,810	199,000	17,700
% Change	-39.9	+165.2	-27.9	+17.5	-46.7	-56.8	+39.9

Table II-74(cont.).

	Rhode Island	Conn.	New York	New Jersey	Delaware	Maryland	Virginia
SEADUCKS							
Eider	-	-	-	-	-	-	-
Scoter	-	15	2,890	11,000	45	16,000	10,842
Old Squaw	-	20	3,221	4,815	-	2,800	792
TOTAL 1976	-	35	6,111	15,815	45	18,800	11,634
TOTAL 1975	1,035	171	2,528	6,140	10	8,800	600
% Change	-	-79.5	+141.7	+157.5	+350.0	+113.6	+1,839.0
GEESE							
Snow Goose	-	2	-	25,700	5,110	3,600	25,065
Blue Goose	-	-	-	10	-	700	260
Canada Goose	1,761	6,044	11,441	15,405	61,245	491,400	64,268
Brant	-	-	17,040	99,000	1,135	1,600	6,900
TOTAL 1976	1,761	6,046	28,481	140,115	67,490	497,300	96,493
TOTAL 1975	1,849	1,550	33,289	94,390	42,655	558,000	56,700
% Change	-4.7	+240.0	-14.4	+48.4	+58.2	-10.8	+70.1
SWANS							
Whistling Swans	-	-	7	300	395	28,500	7,110
Mute Swan	215	659	719	665	20	-	
TOTAL 1976	215	659	726	965	415	28,500	7,110
TOTAL 1975	477	495	722	1,158	421	36,424	200
% Change	-54.9	+33.1	0.0	-16.6	-1.4	-21.7	+255.5
COOTS							
TOTAL 1976	-	-	2,655	1,375	235	3,300	33,038
TOTAL 1975	-	-	1,425	550	615	400	5,000
% Change	-	-	+86.3	+150.3	-61.7	+725.0	+560.7

While the black duck is a migratory winter visitor in Maryland and Virginia it is a year round resident in parts of New Jersey, Rhode Island and Massachusetts and points farther north (TRIGOM, 1974).

Divers. The greater scaup Aythya marila, is common along the Atlantic Coast from Quebec to Florida on bays, salt water ponds, estuaries, and large harbors. It also frequents brackish or freshwater ponds near the sea. It "rafts" with the lesser scaup Aythya affinis.

The greater scaup does not breed in the area under consideration in this statement.

Its predators include man, gulls, hawks, and owls. In addition to natural predation this species is susceptible to oiling and to parasitism and disease.

These birds, as "divers", often feed in fairly deep water away from shore and often feed at night. They eat approximately equal amounts of vegetable and animal matter. Their diet includes wild celery, eelgrass and its seeds; small mollusks and crustaceans, crabs, starfish and mussels. In New York the greater scaup is the most numerous and widespread of all winter ducks and is reported every month of the year (TRIGOM, 1974).

The bufflehead Bucephala albeola, is a diver which usually feeds on animal matter. Its diet includes worms, shrimp and other crustaceans, bivalves and other small mollusks, insects, and small amounts of vegetable matter.

This species typically inhabits the protected salt water of estuaries and bays but is rarely found on the open ocean, or if so, on the close-in shore or surf.

Predators include man, hawks, owls, gulls. The duck is susceptible to oiling, parasitism and disease. Breeding does not occur in the area of this proposal (TRIGOM, 1974).

Sea Ducks. A sea duck, the old squaw (Clangule hyemalis) winters on the Atlantic coast from Newfoundland to North Carolina. It is an especially abundant winter visitor to New Jersey and Long Island Sound, particularly at the east end of the Sound or nearby bays. It is found in fewer numbers along the ocean and in the inlets along the South Shore. This duck is generally uncommon before October and after April although it has been reported for every month.

The habitat of the old squaw includes shallow onshore waters with sandy bottoms and mussel beds, large estuaries and harbors. It is also found in the ocean near rocky shores.

Diet of this species includes mussels (Mytilis edulis) and other mollusks; shrimp and fleas, crustaceans, insects, small fish, some seaweed and aquatic plants. While not considered good eating, many are shot because they mix with scoters. They are preyed upon by hawks, gulls and owls, in addition to man (TRIGOM, 1974).

The Canada goose Branta canadensis, breeds mainly from New England north and therefore seldom breeds in the area of this proposal. However, individuals winter from Nova Scotia to South Carolina and

migrate all along the Eastern Seaboard.

Canada geese live on sand and mud flats, marshes, upland grazing areas in freshwater ponds, and swamps. They also frequent coastal estuaries, and bays and ponds, but usually nest on the ground near water. A typical nest consists of a depression with leaves, grass, and a down lining. The nest is usually sheltered by vegetation.

Diet is largely vegetable and consists of sprouting grain (wheat corn, barley, rye, oats) and grasses; earthworms, insects and larvae; crustaceans; marsh grasses and aquatic plants; marine plants and mollusks. Predators include the fox, skunk, weasels, hawks, eagles and man (TRIGOM, 1974).

Food Relationships

Qualitative data on birds' diets are also given in TRIGOM (1974). They list food preferences for some birds of the area. Since most birds are adventitious feeders, food data are approximations based on available data.

Migration And Breeding

A feature of the life cycle of many bird species is their annual migration to and from breeding grounds (TRIGOM, 1974). Migration times and routes vary according to species but, for the most part, occur in the spring and fall. Routes generally follow the coastline closely.

Due to the heavy urbanization in the northern portion of the Mid-Atlantic area, primary breeding grounds are restricted to the southern areas. The bays, estuaries, and marshes as a habitat type provide breeding areas for many species of birds. Figures II-57 and II-58 illustrate many important breeding and refuge areas in the Mid-Atlantic area. Other wildlife and refuge areas are listed in section II.G.1.e. and shown on Visual 1.

Endangered Species and Species of Concern

The Mid-Atlantic area supports a large and diverse avifauna, most of which have maintained steady population levels. Some species, however, have declined in numbers. Three are considered to be "endangered" by the U.S. Department of the Interior (1974): bald eagle (Haliaeetus leucocephalus), peregrine falcon (Falco peregrinus), and eskimo curlew (Numenius borealis).

Populations of the bald eagle occur in the areas surrounding the Chesapeake and Delaware Bays. Nesting sites for this species are also known to occur there. There are 75 known bald eagle nests in the Chesapeake Bay area. No nests, however, are found north of Annapolis, Maryland, and the York and James Rivers of Virginia have few birds. There are two to three nests on the Delaware Bay (one at Bombay Hook National Wildlife Refuge, Delaware, and the remainder in New Jersey)[1].

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[1] Stan Wiemeyer, Patuxent Wildlife Research Center, personal communication, 1976.

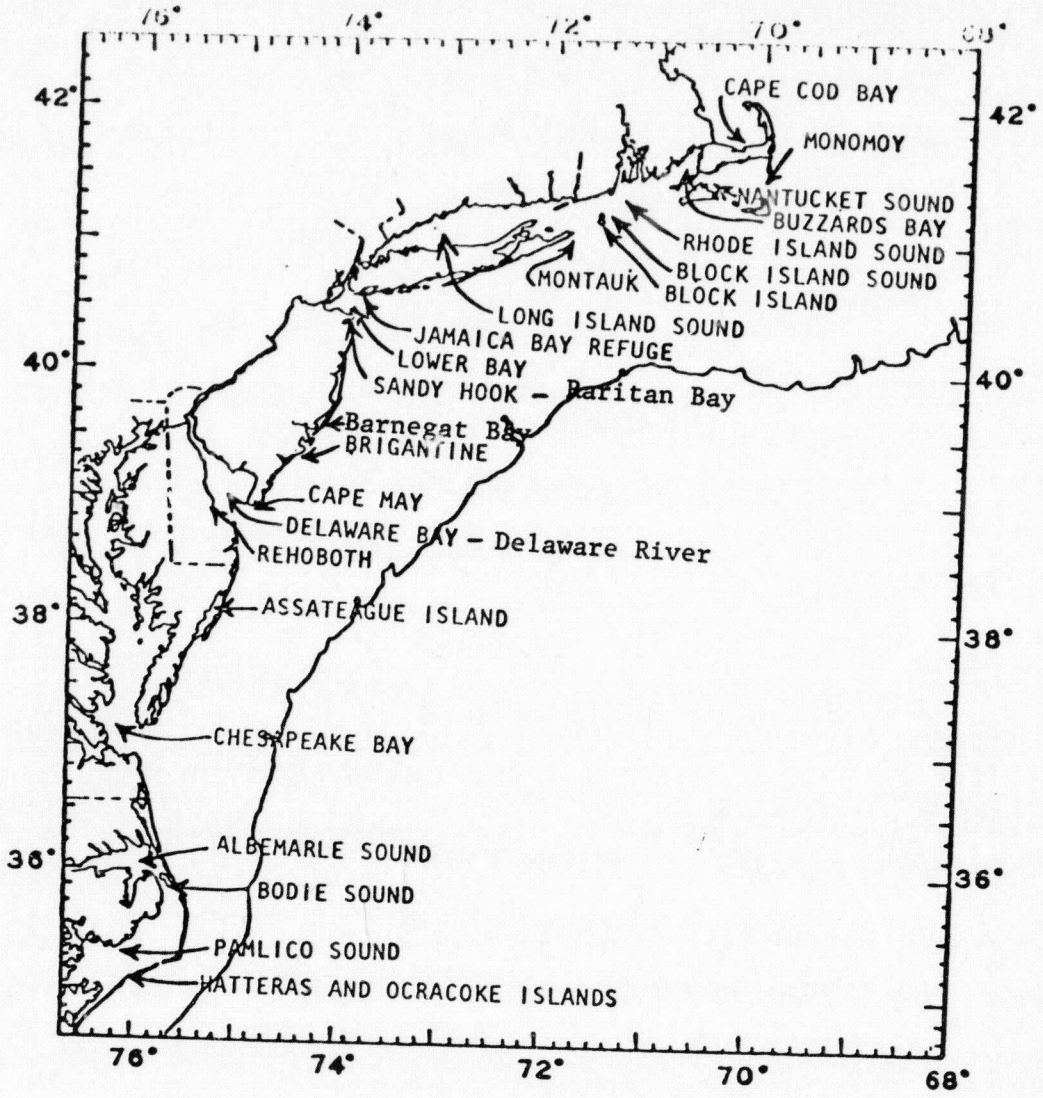

Figure II-57. Principal Water and Land Concentrating Points During Migration (Adapted from Heppner and Gould, 1973)

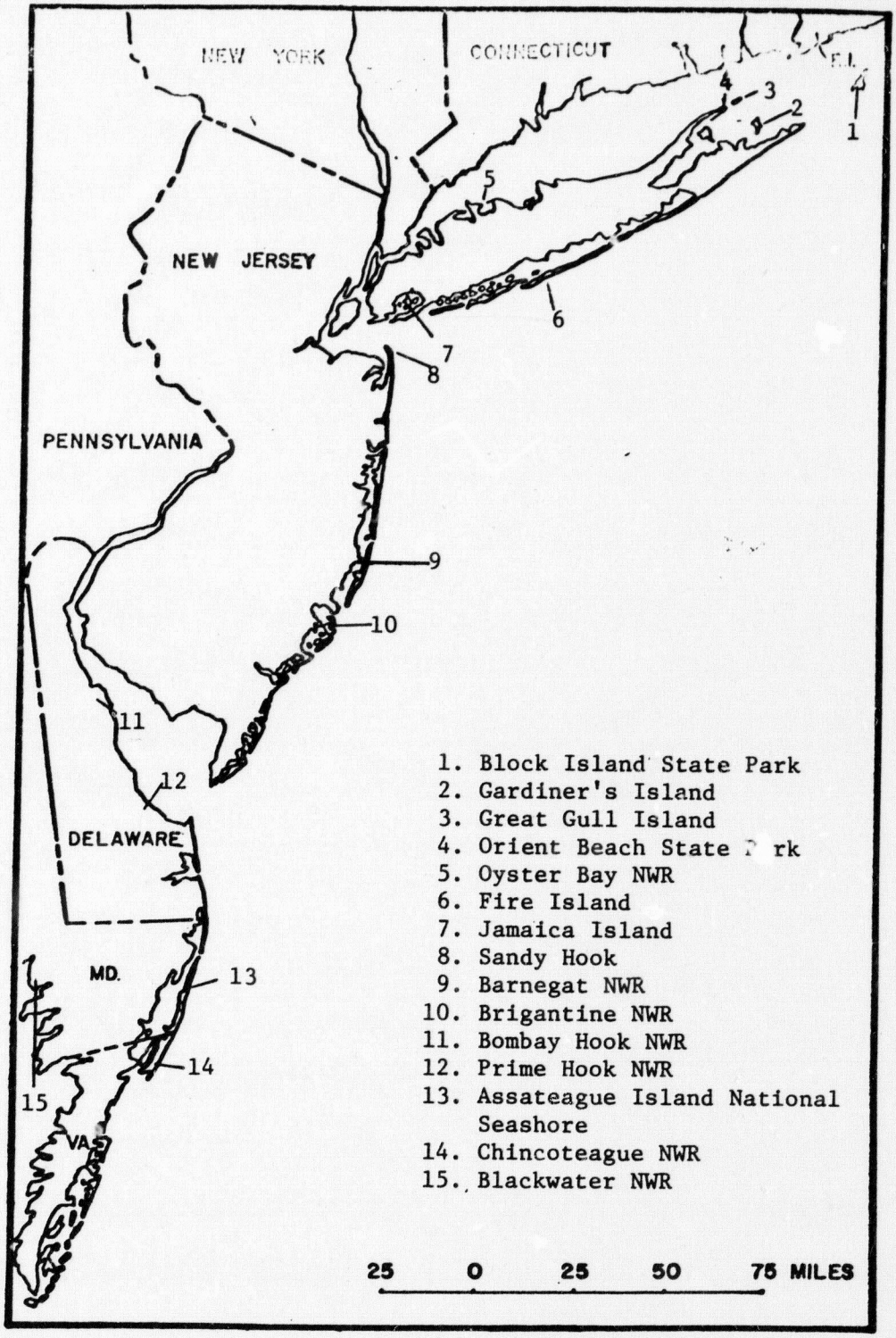

Figure II-58. Selected Major Refuge and Breeding Areas (Adapted from Heppner and Gould, 1973)

The peregrine falcon is rarely sighted in the area. Only a few birds are known to exist in the wild in the Mid-Atlantic region. These are located in the vicinities of Aberdeen, Maryland, and Barnegat Bay, New Jersey. The interagency recovery team assigned to eastern populations of the peregrine falcon is in the process of undertaking a project to reintroduce birds to their former range by utilizing the propagation techniques pioneered at Cornell University[1].

The eskimo curlew also appears on the endangered species list. There is considerable debate as to whether this bird is endangered or is now extinct. Heppner and Gould (1973) report sightings during migration periods on Long Island and at Cape May. If the bird is not currently extinct, its population is certainly very small.

Another species of considerable concern is the osprey (Pandion haliaetus). These birds formerly appeared in great abundance but their populations have declined by at least 80% (and quite possibly 90% or more) since 1950, primarily due to organochlorine pesticides. New Jersey and New York were formerly the centers of coastal populations of aspreys. Unfortunately populations in these areas were also the most devasted by organochlorine pesticides. Today

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[1]Rene Ballengier, Fish and Wildlife Service, Concord, New Hampshire; personal communication.

there are only 68 nesting pairs of osprey in New Jersey[1]. Delaware, Maryland, and Virginia have 46, 31, and 84 nesting pairs, respectively, and the Chesapeake Bay has 1450 pairs. The southern shore of Long Island, however, has only three nesting pairs.[2]

Heppner and Gould (1973) also named several other birds found in the area which could be of special concern along the Mid-Atlantic coast and Chesapeake and Delaware Bays: the Ipswich sparrow, brant, and canvasback duck.

Several factors are responsible for the decline of many species. Among those listed are overhunting, natural disasters, decline and destruction of habitat, and various forms of pollution (Heppner and Gould, 1973).

c. Wildlife

Associated with the coastal habitats of the Mid-Atlantic region are various mammals, reptiles, and amphibians. As described in previous sections, dunes, marshes (salt and fresh), bogs, brush, and woodlands are found in coastal areas and provide habitats for wildlife forms other than birds.

The largest percentage of mammals reported in the coastal areas are rodents and carnivores. Table II-75 summarizes distribution in the Mid-Atlantic region of common coastal mammals by habitats.

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[1]Dr. Charles Henny, Denver Research Center, personal communication.

[2]Paul Spitzer, Cornell University, personal communication.

Table II-75. Mammals Common to the Mid-Atlantic Coastal Region by Habitat

	Barrier Beach	Salt Marsh	Freshwater Marsh	Pine Barrens	Hard-woods
Marsupials					
Opossum *Didelphis virginiana*	x	x	-	x	x
Moles					
Eastern Mole *Scalopus aquaticus*	-	-	-	x	x
Starnosed Mole *Condylura cristata*	-	-	x	-	-
Shrews					
Masked Shrew *Sorex cinereus*	x	x	x	x	x
Shorttail Shrew *Blarina brevicauda*	-	-	-	x	x
Least Shrew *Cryptotis parva*	-	-	x	x	x
Bats					
Little Brown Myotis *Myotis lucifugus*	x	x	x	x	x
Small-footed Myotis *Myotis subulatus*	-	-	x	x	x
Silver haired Bat *Lasionycteris noctivagans*	-	x	x	-	-
Eastern Pipistrel *Pipistrellus subflavus*	x	x	x	x	x
Big Brown Bat *Eptesicus fuscus*	x	x	x	x	x
Red Bat *Lasiurus borealis*	-	-	-	x	x
Hoary Bat *Lasiurus cinereus*	-	-	-	x	x

Table II-75. Continued.

	Barrier Beach	Salt Marsh	Freshwater Marsh	Pine Barrens	Hard-woods
Rabbits					
Eastern Cottontail *Sylvilagus floridanus*	x	-	-	x	x
Rodents					
Woodchuck *Marmota monax*	-	-	-	x	x
Eastern Chipmunk *Tamias striatus*	-	-	-	x	x
Red Squirrel *Tamiasciurus hudsonicus*	-	-	-	x	x
Eastern Grey Squirrel *Sciurus carolinensis*	-	-	-	x	x
Southern Flying Squirrel *Glaucomys volans*	-	-	-	x	x
Rice Rat *Oryzomys palustris*	-	x	x	-	-
White-footed Mouse *Peromyscus leucopus*	x	-	x	x	x
Boreal Redback Vole *Clethrionomys gapperi*	-	-	-	x	x
Meadow Vole *Microtus pennsylvanicus*	x	x	x	x	x
Pine Vole *Pitymys pinetorum*	-	-	-	x	x
Muskrat *Ondatra zibethicus*	-	x	x	-	-
Norway Rat *Rattus norvegicus*	-	x	x	-	-
House Mouse *Mus musculus*	x	-	-	x	x
Meadow Jumping Mouse *Zapus hudsonius*	x	-	-	-	-

Table II-75. Continued.

	Barrier Beach	Salt Marsh	Freshwater Marsh	Pine Barrens	Hard-woods
Carnivores					
Red Fox *Vulpes fulva*	-	-	-	x	x
Gray Fox *Urocyon cinereoargenteus*	-	-	-	x	x
Racoon *Procyon lotor*	-	x	x	x	x
Longtail Weasel *Mustela frenata*	-	-	x	x	x
Mink *Mustela vison*	-	x	x	-	-
Striped Skunk *Mephitis mephitis*	-	-	-	x	x
River Otter *Lutra canadensis*	-	x	x	-	-
Herbivores					
Deer					
Whitetailed Deer *Odocoileus virginianus*	-	-	x	x	x
Ponies *Equus* sp.	-	x	x	x	x

Sources:

Department of Environmental Protection, State of New Jersey (1975)
Metzgar, R. G. (1973)
U.S. Fish and Wildlife Service

Table II-76 provides information on wildlife of the Chesapeake Bay Basin.

Unique to Assateague Island are the horses (ponies) Equus sp., located in the Chincoteague National Wildlife Refuge, which number 115 head plus 30 foals. These animals, which have lived on Assateague Island since the 1600's, consume cordgrass and brush of the fresh and brackish water marshes, and live from the brush to the mixed hardwood and pine of the island's interior (see Table II- 75).

Reptiles and amphibians also occur in the coastal areas. Many of them, especially amphibians, have life cycles dependent on wetlands. Table II-77 and Table II-78 list some reptiles and amphibians common to the Mid-Atlantic coastal area.

Marine turtles also found in the area include Atlantic green turtle (Chelonia mydas mydas), Atlantic hawksbill turtle (Eretmochelys imbricata imbricata), Atlantic loggerhead (Caretta caretta caretta), Atlantic ridley (Lepidochelys kempi), Atlantic leatherback (Dermochelys coriacea coriacea), and northern diamondback terrapin (Malaclemys terrapin).

TABLE II-76.
SUMMARY OF HABITAT TYPES AND RELATIVE WILDLIFE VALUES
CHESAPEAKE BAY BASIN
(US Army Corps of Engineers, 1972)

Wildlife Species	Coastal Saline Wetlands	Coastal Fresh Wetlands	Inland Fresh Wetlands	Wooded Uplands	Non-wooded Uplands	Urban Areas
White-tailed Deer	Low	Moderate	Moderate	High	High	None
Gray and Red Squirrels	None	None	None	High	Moderate	None
Fox Squirrel	None	None	None	High	Moderate	None
Cottontail Rabbit	Low	Moderate	Moderate	High	High	None
Wild Turkey	None	None	None	High	Moderate	None
Pheasant	None	Moderate	High	Moderate	High	None
Ruffled Grouse	Low	Low	Moderate	Moderate	High	None
Bobwhite Quail	Low	Moderate	Moderate	Moderate	High	None
Woodcock	None	Moderate	High	Moderate	Low	None
Mourning Dove	None	None	None	High	High	None
Gray Fox	Low	Low	Low	High	High	None
Red Fox	Low	Low	Low	High	High	None
Raccoon	Moderate	Moderate	High	High	Moderate	None
Opossum	None	Low	Low	Moderate	High	None

TABLE II-76. Continued

Wildlife Species	Coastal Saline Wetlands	Coastal Fresh Wetlands	Inland Fresh Wetlands	Wooded Uplands	Non-wooded Uplands	Urban Areas
Beaver	None	Low	High	Low	Low	None
Otter	None	Moderate	High	Low	Low	None
Mink	Low	High	High	Low	Low	None
Muskrat	Moderate	High	High	None	None	None
Skunk	None	Low	Moderate	High	Moderate	None
Woodchuck	None	None	None	Low	High	None
Rails and Gallinules	High	High	Low	None	None	None
Jack Snipe	High	High	Moderate	None	Low	None
Geese	Moderate	Moderate	Moderate	None	High	None
Brant	High	Low	None	None	Low	None
Ducks	High	High	High	Low	Moderate	None
Coots	Moderate	High	High	None	Low	None

County also.

Table II-77. Reptiles Common to the Mid-Atlantic Coastal Region by Habitat

	BB	SM	FM	PB	HW
Turtles					
Common Snapping Turtle - *Chelydra serpentina*	x		x	x	x
Stinkpot - *Sternotherus odoratus*	x		x	x	x
Eastern Mud Turtle - *Kinostèrnon subrubrum*		x	x	x	
Spotted Turtle - *Clemmys guttata*			x	x	x
Eastern Box Turtle - *Terrapene carolina*	x			x	x
Northern Diamondback Terrapin - *Malaclemys terrapin*	x	x			
Eastern Painted Turtle - *Chrysemys picta*			x	x	x
Red-bellied Turtle-*Pseudemys rubriventris*				x	
Lizards					
Northern Fence Lizard - *Sceloporus undulatus hyacinthinus*				x	x
Five-lined Skink - *Eumeces fasciatus*				x	x
Snakes					
Water Snake - *Natrix sipedon*			x	x	x
Brown Snake - *Storeria dekayi*				x	x
Garter Snake - *Thamnophis sirtalis*			x	x	x
Ribbon Snake - *Thamnophis sauritis*			x	x	x
Ringneck Snake - *Diadophis punctatus*				x	x
Racer - *Coluber constrictor*	x		x	x	x
Smooth Green Snake - *Opheodrys vernalis*					x
Rough Green Snake - *Opheodrys aestivus*				x	x
Milk Snake - *Lampropeltis doliata*				x	x
Kingsnake - *Lampropeltis gerulus*			x	x	x
Mildsnake - *Lampropeltis triangulum*			x	x	x

Source:

Department of Environmental Protection, State of New Jersey, 1975

U.S. Fish and Wildlife Service

KEY: BB-Barrier Beach SM-Salt Marsh FM-Freshwater Marsh
PB-Pine Barrens HW-Hardwoods

The Baltimore region is defined here to include

Table II-78. Amphibians Common th the Mid-Atlantic Coastal Region by Habitat. BB-Barrier Beach; SM-Salt Marsh; FM-Freshwater Marsh; PB-Pine Barrens; HW-Hardwoods

Salamanders	BB	SM	FM	PB	HW
Marbled Salamander - Ambystoma opacum			x	x	x
Spotted Salamander - Ambystoma maculatum			x		x
Tiger Salamander - Ambystoma tigrinum			x	x	
Red-spotted Newt - Notophthalmus viridescens			x	x	x
Dusty Salamander - Desmognathus fuscus			x		x
Redbacked Salamander - Plethodon cinereus				x	x
Four-toed Salamander - Hemidactylium scutatum			x		x
Red Salamander - Pseudotriton ruber			x	x	x
Mud Salamander - Pseudotriton montanus			x		
Two-lined Salamander - Eurycea bislineata			x		x
Toads and Frogs					
Spadefoot Frog - Scaphiopus holbrooki			x		x
American Toad - Bufo americanus			x		x
Fowler's Toad - Bufo woodhousei fowleri	x	x	x	x	x
Cricket Frog - Acris crepitans			x	x	x
Spring Peeper - Hyla crucifer			x	x	x
Pine Barrens Treefrog - Hyla andersoni			x	x	
Gray Treefrog - Hyla versicolor			x		x
Chorus Frog - Pseudacris triseriata			x	x	x
Bullfrog - Rana catesbeiana			x		x
Carpender Frog - Rana virgatipes			x	x	
Green Frog - Rana clamitans			x		x
Leopard Frog - Rana pipiens		x	x	x	x
Pickerel Frog - Rana palustris			x		x
Wood Frog - Rana sylvatica			x		x

Source:

Department of Environmental Protection, State of New Jersey ,1975

U.S. Fish and Wildlife Service

Endangered Wildlife Species

Wildlife species classified as endangered by the U.S. Department of the Interior which occur in the area are as follows:

Rodents

Delmarva Peninsula Fox Squirrel (*Sciurus niger cinereus*) - Stable populations reside in Blackwater and Eastern Neck Refuges. Some individuals have been recently transplanted to Chincoteague National Wildlife Refuge and thought to have stabilized (U.S. Department of the Interior, Fish and Wildlife Service).

Species which are listed on State endangered species lists are not included because it is felt that the Federal endangered species list is more uniformly representative of species whose populations are in danger of extinction from their entire range.

G. Man's Use of the Environment

1. Land and Water Use

a. General Description of Land Uses and Distribution

The Mid-Atlantic region is generally a heavily developed and industrialized region, influenced primarily by corridors and cores of industrialization. The largest corridor stretches from the Port of New York and New Jersey, southwest to Philadelphia and Wilmington. Another core of urban development surrounds the industrialized port of Baltimore and the Washington, D.C., metropolitan area. In the southern part of the region, an industrialized core centers around the Hampton Roads area of Virginia. Despite its developed character, however, the region exhibits great diversity and has many rural areas, as discussed below.

The land use of the Mid-Atlantic region will be discussed by breaking the region into nine smaller regions. These subregions are shown in Figure II-59 .

Other parts of this section (II.G.1.b.through e) will deal more explicitly with port facilities, recreation and shoreline use, in the Mid-Atlantic region. In addition, the wetland resources of the Mid-Atlantic coastal counties are discussed in II.A.4.

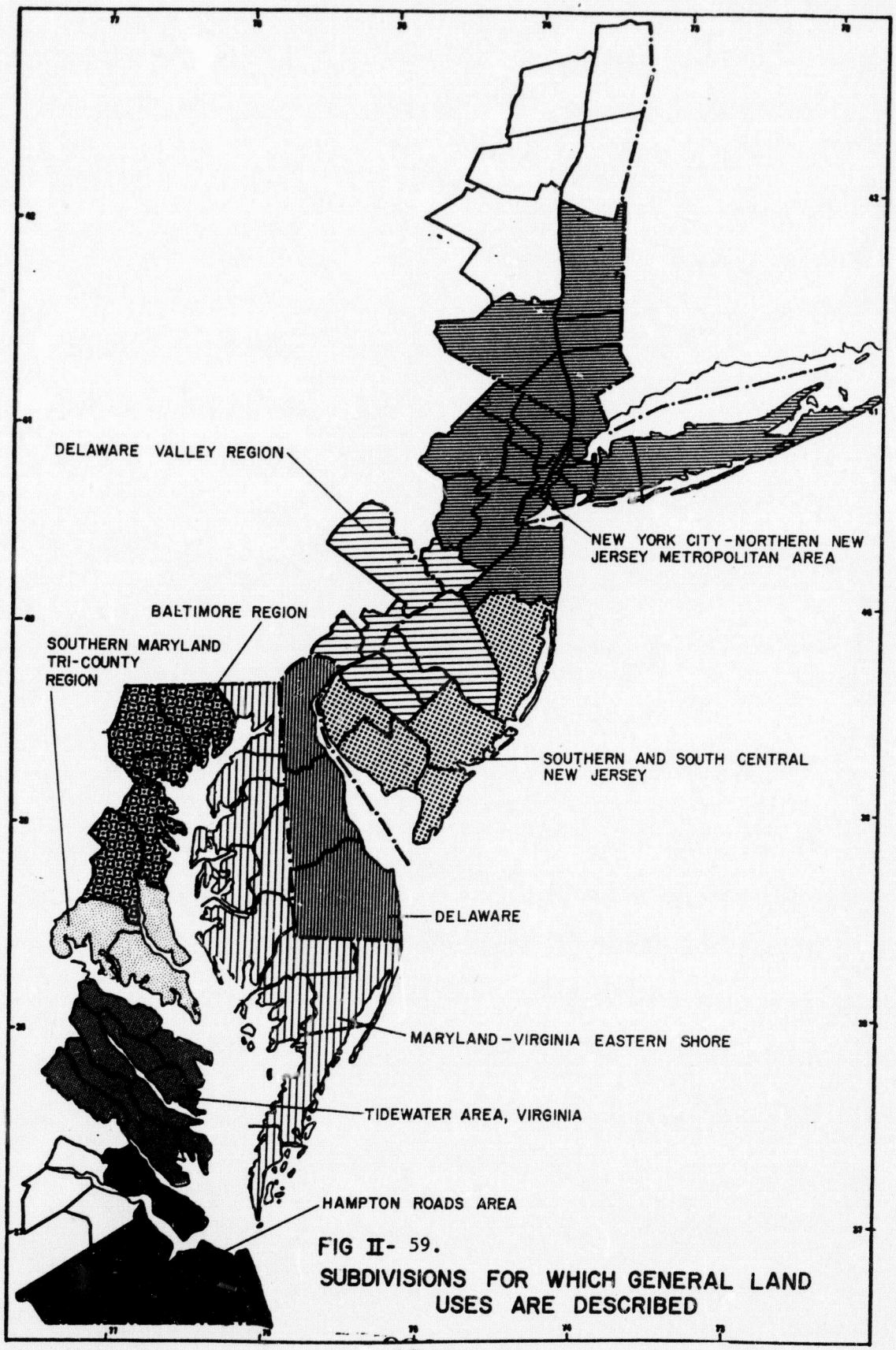

FIG II- 59.
SUBDIVISIONS FOR WHICH GENERAL LAND USES ARE DESCRIBED

An overview of land characteristics and land use in the entire Atlantic Coastal region may be found in the Final EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol.1, pp. 431-459.

New York City-Northern New Jersey Metropolitan Area

This 21 country area, including the five New York City counties, had a 1970 total population of over 14 million people. The area is dominated by the industrial activity centering around the Port of New York and New Jersey, as well as the job market in Manhattan and the surrounding areas of the city which creates an extensive commuter shed. The port facilities occupy 755 miles of water frontage. A detailed discussion of the Port of New York and New Jersey can be found in the subsequent subsection (II.G.1.b.)

Forty-five percent of the land area of the New York segment of the region is developed. New York City is, of course, the most extensively developed, with over 90 percent of its acreage in the developed category. The outer suburban counties--Dutchess, Orange, and Putnam--are the least developed, while Long Island, Westchester, and Rockland counties are characterized by greater degrees of suburbanization.

The New Jersey portion of the region exhibits much the same development pattern. The counties adjacent to New York City--Essex, Hudson, and Union--are highly industrialized. The northern

New Jersey refineries are located in Middlesex and Hudson Counties.

The counties surrounding the earlier established industrial and population centers of the New York and Newark area have experienced particularly rapid and more or less uncontrolled development in the past two or three decades, resulting in diverse patterns of residential, commercial, and manufacturing uses. Remaining agricultural and other unprotected open land is generally subject to intense development pressure.

Despite the developed character of the region, there are significant natural areas within the region. Of particular importance for this statement are the coastal resources of Long Island and Monmouth County, New Jersey.

Nassau County, adjacent to New York City, is the more intensely developed of the two Long Island counties. Only 6 to 7 percent of the land in Nassau County is described as vacant, while 41 percent of Suffolk County is vacant (Koppelman, 1974). The development of both counties is characterized by single, detached housing, large shopping center complexes, and commercial and industrial development along highway corridors. Older urban centers are on the decline. The majority of residential development in Nassau County is medium density, while in Suffolk County, almost half the housing is low density.

Important wetlands are located in both counties. Several thousand acres of marine tidal wetlands exist along the Atlantic shoreline of Long Island. Extensive barrier islands also stretch along Long Island's Atlantic shoreline, supporting both private and public recreation in the form of permanent and seasonal homes and day use. Most of the remaining open land on the Atlantic shore side of Long Island is located at the eastern end of Suffolk County.

As previously indicated, New York City is more than 90 percent developed. Because the land use pattern of the city is thus fairly fixed, new industries or companies locating within the city could be expected to be absorbed into existing industrial or commercial areas. Of particular importance to activities associated with OCS development is the port area and its facilities, described in a later section.

Monmouth County, New Jersey, is a suburban county of the New York metropolitan region. Early development took place along the ocean, the bays, and around older rural centers inland. With the construction of modern highways, the development pattern has shifted. Recent development has taken place along the Garden State Parkway (generally paralleling the coast) and state highways. While the county plan calls for some new industrial and commercial development, particularly research and offices, areas designated for industrial siting are located away from the coastline and generally

are located along highway and rail corridors.

In 1970, there was only a little over 2,000 acres of wetlands in Monmouth County. Much of the shoreline is beach, and while most of the beach proper is retained for recreational use, both public and private, the adjoining shoreline area is generally developed and in residential use.

Southern and South Central New Jersey

Southern and south central New Jersey counties include much of New Jersey's public open space and other open land. While relatively undeveloped as a whole, it is nonetheless diversified. Salem County is almost half agricultural, while there are relatively smaller amounts of agricultural land in the other counties despite their open character. Salem County is subject to development pressures from the greater Philadelphia-Camden area. Atlantic and Ocean Counties are more than half forested, while Cape May and Cumberland Counties are more than one-third forested. Over 370,000 of the forested acreage in Ocean and adjoining Burlington Counties make up the Pine Barrens, a pine forest atop a perched water table and a valuable aquifer. Atlantic, Ocean, and Cape May Counties all receive extensive recreational use of their shoreline, although more private recreational use takes place in Ocean and Cape May Counties, as evidenced by their high percentages of seasonal home units, 27 and 47 percent respectively, as compared

to Atlantic County's 8 percent seasonal home ratio.

The coast of Ocean County is presently undergoing a change from a primarily seasonal and resort orientation to a permanent residential area as pressures from the New York metropolitan area are felt. Between 1960 and 1970, the population of the county more than doubled.

While development has concentrated along Route 9, which follows the coast, legislative restrictions may force development inland. Forty-five percent of the county falls under the jurisdiction of New Jersey's Coastal Area Facility Review Act. Of the area classified as agricultural or vacant (about 40 percent of the County), nearly half is pinelands or wetlands. The pinelands, or Pine Barrens, are located west of the Garden State Parkway in the central portion of the County.

Atlantic City is the focal point and population center of Atlantic County. It is a major shore resort area and has two large convention centers which contribute substantially to its resort orientation. The barrier beach communities of the county (including Atlantic City) are extensively developed. The mainland shore area is more suburban in orientation. High housing costs in the Atlantic City area have been forcing more people to move onto the mainland. Between the barrier islands and the mainland and extending up the rivers are tidal marshlands. In the vicinity of the barrier island

communities and certain areas of the mainland, the marshlands are coming under increasing development pressure because of lack of alternative land for expansion.

Agriculture is considered an important economic activity in the county. The western and central portions of the county are the dominant farming centers. The western parts of the county have not felt heavy development pressures as yet. However, the proposed extension of the Lindenwold Highspeed Line from the Philadelphia area could put more development pressure on the inland area.

Cape May County is primarily rural with its population concentrated along the shoreline. Tourism and recreation are the economic base of the county. Beaches and public as well as private recreational developments are scattered along much of the suitable shoreline. The largest town, Ocean City, had a 1970 population of only 10,000. Important wetlands are also located in Cape May County, covering almost one third of the land area. According to analyses performed by Resource Planning Associates and reported by CEQ (Oil and Gas--An Environmental Assessment, 1974) most of Cape May County is unavailable or unsuitable for primary development because of the extensive beaches, salt marshes, and recreational land.

Delaware Valley Region

This region includes the three Pennsylvania counties which are included in that State's coastal zone management planning and the four New Jersey counties centering around the Philadelphia-Camden metropolitan area which border on the Delaware River. Trenton, the New Jersey State Capital, is in Mercer County.

The most intensive development, particularly industrial, lies along the Delaware River. Philadelphia and Camden form the core of this development. Of particular significance are the refineries located in Delaware and Philadelphia Counties in Pennsylvania and Gloucester County, New Jersey (Visual 5). A description of the Delaware River port facilities, including petroleum handling facilities, may be found in the subsequent subsection (II.G.1.b.).

Extending out from the core area are suburban and mixed-use areas. The most extensive rural areas are in Bucks and Burlington Counties as they extend away from the River.

Delaware

In 1964, less than 8 percent of Delaware was classified as urban, and more than half the urban acreage was in New Castle County.

Wilmington forms the southern end of the urban industrial corridor stretching from the Hudson River. The port city of Wilmington is

Domestic crude volume within the harbor declined proportionately

in New Castle County, which accounts for its more developed character. A discussion of the port may be found in the subsequent subsection (II.G.1.b.).

Both Kent and Sussex Counties are generally rural in character, particularly Sussex County. Both have extensive amounts of farmland, as well as forested acreage. Over one third of Sussex County was in harvested cropland and pasture in 1964.

Sussex County has Delaware's only Atlantic shoreline. Its shorefront stretches for about 25 miles. Forty-six percent of the coastal zone area of the county (almost 55,000 acres) is tidal marsh. Wetlands are concentrated along Rehoboth, Indian River, and Little Assawoman Bays. Rehoboth and Indian River Bays, in particular, are under development pressure. The shorefront itself constitutes an important recreational resource. Rehoboth Beach, Bethany Beach, Fenwick Island, and Cape Henlopen are principal recreation and/or resort areas. Despite recreational development in the coastal zone, it is primarily undeveloped. Almost 85 percent of the coastal zone of the county is classified as agricultural or other open land. Lewes, the principal town in the county, has a population of only 2,500.

Maryland-Virginia Eastern Shore

This region includes all of the nine Maryland counties east of Chesapeake Bay, as well as Accomack and Northampton

There are a number of deep draft wharves and piers along the

Counties in Virginia. The area includes just over 150 miles of Atlantic shoreline. As a whole, the region is rural. Several of the counties have only a few incorporated towns. The total population of the region is under 250,000.

Wicomico and Cecil Counties are the most developed. Cecil County is feeling development pressures from Wilmington, Delaware, and is included in the Wilmington Standard Metropolitan Statistical Area (SMSA). Salisbury, Maryland, the largest town in the region, is in Wicomico County. It serves as an employment and commercial center for the region.

A great deal of the land area in the region is devoted to agriculture. Wicomico County, which is relatively developed, reported 85 percent of its land as agricultural.

Generally, development in the region is clustered around the incorporated and unincorporated towns and villages. There are also scattered clusters of nonfarm residential areas. Residences and seasonal homes are often concentrated along the waterfront areas, both on the Chesapeake Bay and the Atlantic shoreline.

Worcester County is primarily rural, with significant recreational use of its shoreline. This is evidenced by the fact that 34 percent of the county's residences are seasonal home units. The northern nine miles of Atlantic shoreline encompass Ocean City, Maryland.

Twenty-two miles of Assateague Island are included in Worcester County also.

Pocomoke City is the largest municipality, with a population of only 3,573 in 1970. The Ocean City population was only 1,493. However, the summer population of Ocean City reportedly rises to 35,000 during weekdays and 75,000 during weekends. In 1960, the four incorporated towns in the County accounted for one percent of the total county land use.

In the Virginia shore counties, almost 25 percent of Northampton and 20 percent of Accomack Counties are wetlands, primarily on the seaside of the peninsula. Slightly higher percentages are devoted to cropland. In addition, substantial portions of both counties are forested. Only about 2 percent of the acreage is in developed uses. Industrial use is limited to a few large plants and several scattered manufacturing or food processing plants.

Historically, development on Virginia's eastern shore has centered around the towns and villages, either coastal fishing towns or inland centers servicing farm areas. However, development patterns have shifted. Residences have scattered along secondary roads, and subdivisions and seasonal homes are developing along the shoreline. Commercial enterprises are spreading along Route 13, the main transportation artery which follows the spine of the peninsula.

Baltimore Region

The Baltimore region is defined here to include the independent city of Baltimore, Baltimore County, and Harford and Anne Arundel Counties which front on the Chesapeake Bay. The city of Baltimore is heavily urbanized and industrialized and is heavily influenced by its port facilities. A description of the port facilities may be found in the subsequent subsection (II.G.1.b.). Sparrows Point, which protrudes into the Chesapeake Bay and is in Baltimore County, is the site of a major steel plant and a shipyard. The only drilling rig thus far constructed on the Atlantic Coast (United States) was constructed in this shipyard.

The southern parts of Baltimore County and the northern areas of Anne Arundel County are urbanized or heavily suburban due to the influence of Baltimore City. Development has concentrated especially along the radial highways extending out from Baltimore and along Interstate 95 which runs through Baltimore and between Washington, D.C., and Wilmington, Delaware.

The outer areas of the three counties are rural. There is extensive woodland, as well as agriculture--mostly small farms. Along stream valleys, parts of the Bay and surrounding large reservoirs in the outer counties are dedicated open space areas.

Annapolis, the State Capital and site of the Naval Academy, is located on the Chesapeake Bay in Anne Arundel County. The Aberdeen Proving

Grounds, a former military installation (surplus, but its future status undetermined) covers about 36,000 bayfront acres in Harford County.

Southern Maryland Tri-County Region

The three counties in this region are situated below the Baltimore and Washington urban areas, and are characterized by extensive river and bay shoreline. The area is still quite rural in character, with over 90 percent of its acreage in agriculture or forests.

However, the area is beginning to feel development pressures. Charles County is a part of the suburban fringe to the south of Washington, D.C. and as such, is subject to more and more subdivision and suburban type developments. Calvert and St. Mary's Counties are experiencing increasing demand for vacation and home development.

Tidewater Area, Virginia

This ten-county region is situated between the Maryland-Virginia State line and the highly developed Hampton Roads area of Virginia. It is the least developed area in the Mid-Atlantic region, having population density of only 40 persons per square mile and very little development. There are no incorporated cities in the region. The area is primarily agricultural, although there is also some private recreational use of the coastal areas.

Hampton Roads Area

This area surrounds the mouth of the James River on the Chesapeake Bay. It is bounded on the north by the York River and on the south by the Virginia-North Carolina State line. While it contains only about 5 percent of the land area of Virginia, it contains almost one quarter of the State's population. Most of the population and development in the region is concentrated in the independent cities immediately surrounding Hampton Roads. Industrial activity has developed along the Elizabeth River. The population concentration and developed nature of the area are due to the extensive port activities and resulting industrialization. Associated with the port area is a well-developed shipbuilding industry. A description of the port may be found in the subsequent subsection (II.G.1.b.).

Despite its generally industrialized character, the region is quite diverse. Extensive Federal military acreage exists in Virginia Beach, Chesapeake City, Norfolk, and Portsmouth. Also located in the region are protected natural areas, including the Dismal Swamp. Fifty thousand acres of this swamp area currently are held by the Department of the Interior. Virginia Beach, with its Atlantic shoreline, is an important recreation and resort area.

Virginia Beach, an independent city, has a large portion of the region's farm and forest area. The northern part of the city is a suburban extension of the Norfolk region, stretching to the resort area on the coast. In addition, Federal wildlife refuges and a waterfowl management area are located in Virginia Beach.

b. Ports, Shipping, and Navigation[1]

Landward of the proposed lease sale area are four major harbor areas, the Port of New York and New Jersey, Delaware River, Baltimore Harbor, and Hampton Roads. The ports of this region are major gateways for oceanborne exports and imports. Harbor trends were traced through data compiled by the U.S. Army Corps of Engineers in their Waterborne Commerce of the United States publications. In 1973, 230,220,919 short tons of foreign commerce were handled by these ports, accounting for 49 percent of their total

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[1]A general discussion of ports, shipping and navigation on the entire Atlantic coast may be found in the Final EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol.1,pp. 478-485.

freight traffic. Crude petroleum and petroleum products amounted to 293,874,155 short tons or 62 percent of all waterborne commerce, of which product shipments and receipts accounted for 71 percent and crude for 29 percent. Based upon the Corps of Engineers data, receipts and shipments of crude petroleum totaled 85,190,329 short tons or 604,293,339 barrels (conversion according to Lavorsen, 1967). Seventy-seven percent (65,587,909 short tons) of crude petroleum traffic was generated by foreign imports and exports. Figure II-60 represents total freight and petroleum traffic in the ports during 1973. Through the years extensive water and port-dependent industrial activities have sprung up in and around the port areas. In many of the ports some industrial land and structures are vacant and some may be underutilized or only marginally used. Ongoing planning activities at each of the ports should facilitate land usage and enhance economic development.

Port of New York and New Jersey

The bi-state Port of New York and New Jersey (PNYNJ) is located in an area northwest of the proposed lease sale acreage as depicted on Visual 5. It is the most complex of all the ports in the Mid-Atlantic. Based upon foreign general cargos, it is the Nation's largest port. Generally defined, the PNYNJ includes the Hudson River south of George Washington Bridge, the Harlem River, the East River to the Throgs Neck Bridge, Hackensack and

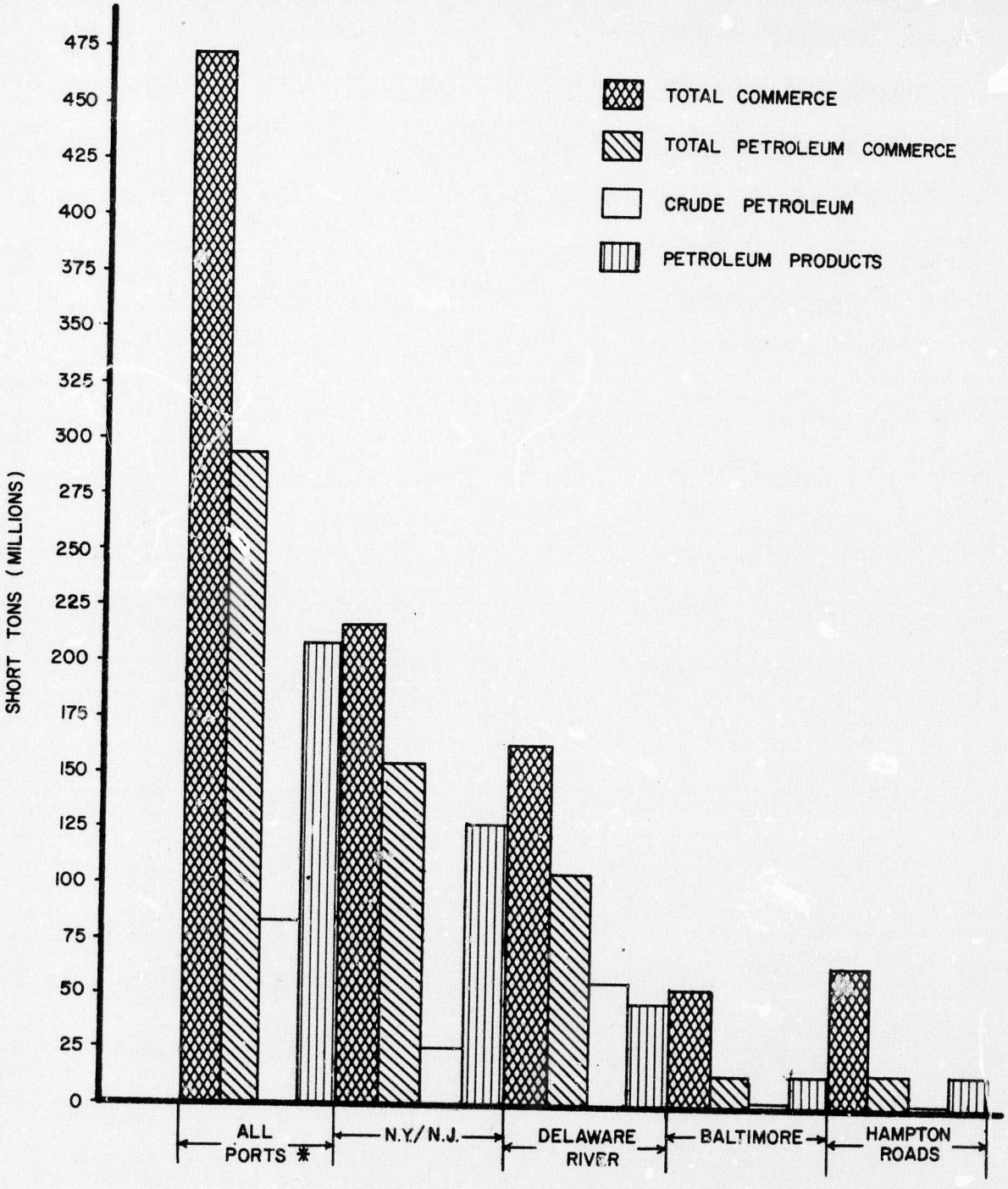

FIGURE II-60. * MAJOR MID-ATLANTIC PORTS
FREIGHT TRAFFIC-1973

(Source of Data: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973)

Passaic Rivers, Newark Bay, the Upper and Lower Bays of New York, Raritan Bay east of Sandy Hook, Raritan River west to New Brunswick, Arthur Kill and the Kill Van Kull. Within a radius of 25 miles of the Statue of Liberty, the PNYNJ encompassess approximately 1,500 square miles of harborage. Because there are many major and minor channels throught the port, depths vary widely. The project depth in the main channel, from the sea to deep water terminals in the Hudson River, is 45 feet. The depths in other channels which may be used to enter the port vary from 9 to 35 feet. There is a traffic separation scheme at the port's entrance for inbound and outbound vessels. A detailed description of the traffic scheme appears in Appendix 8 . This only describes the existing traffic scheme which does not include areas which have traditionally been used by vessel traffic but are not offically established traffic lanes.

The Port has over 1,100 waterfront facilities, most of which have highway and rail connections. Steamship passenger terminals, containership facilities, break-bulk general cargo terminals, grain handling facilities, petroleum and other liquid cargo terminals are to be found among the many waterfront facilities. Petroleum handling facilities are mainly on the Jersey side of the harbor along the Arthur Kill, Kill Van Kull, and Newark Bay.

Until recently, the PNYNJ handled more tonnage annually than any port in the world. During the twenty-year period between 1950 and 1970,freight traffic showed a net increase of 29,064,500 tons or 20 percent. The percentage increase in tonnage, 6 percent, was much

smaller between 1950 and 1965 than it was during the five-year period between 1965 and 1970, at which time it was 13 percent. There was a much sharper increase in freight traffic between 1970 and 1973, during which it rose by 27 percent to 216,896,434 short tons.

As total commerce in the port increased, the total volume of crude petroleum and petroleum products also increased. In 1973, approximately 71 percent of all commerce through the port stemmed from crude and petroleum products. In the twenty-year period from 1950 to 1970, petroleum tonnage increased by 8 percent, with foreign petroleum imports increasing by 47 percent and domestic petroleum shipments decreasing by 9 percent. Within a five-year time frame between 1965 and 1970, both total and imported crude tonnage actually decreased both proportionately and by total volume, while domestic crude increased. Petroleum trends in the harbor are indicated by Table II-78 and Figures II-61 and Figure II-62. If we examine the fifteen-year period between 1950 and 1965, we find a more pronounced change. During this period imports increased by 137 percent, while domestic crude volume only increased by 46 percent. Trends in crude oil shipments reflect the region's greater dependence upon foreign imports. The peak year for domestic crude coming through the harbor was 1950, at which time it accounted for 70 percent of all crude oil cargo.

Table II-78 Port of New York and New Jersey Freight Traffic (Short Tons)

Year	Total Tonnage (TT)	Crude Petroleum Tonnage					
		Total Crude (TC)		Foreign		Domestic	
		Tons	Percent of TT	Tons	Percent of TC	Tons	Percent of TC
1950	144,943,558	16,385,469	11.3	4,947,534	30.2	11,437,935	69.8
1955	148,848,131	17,699,353	11.9	9,254,526	52.3	8,444,827	47.7
1960	153,198,620	17,810,760	11.6	10,388,133	58.3	7,422,627	41.7
1965	153,830,418	17,961,210	11.7	11,742,336	65.4	6,218,874	34.6
1970	174,008,108	17,695,551	4.4	7,261,260	41.0	10,434,291	59.0
1973	216,896,434	26,483,182	12.2	20,459,599	77.3	6,023,583	22.7

(Source: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973.)

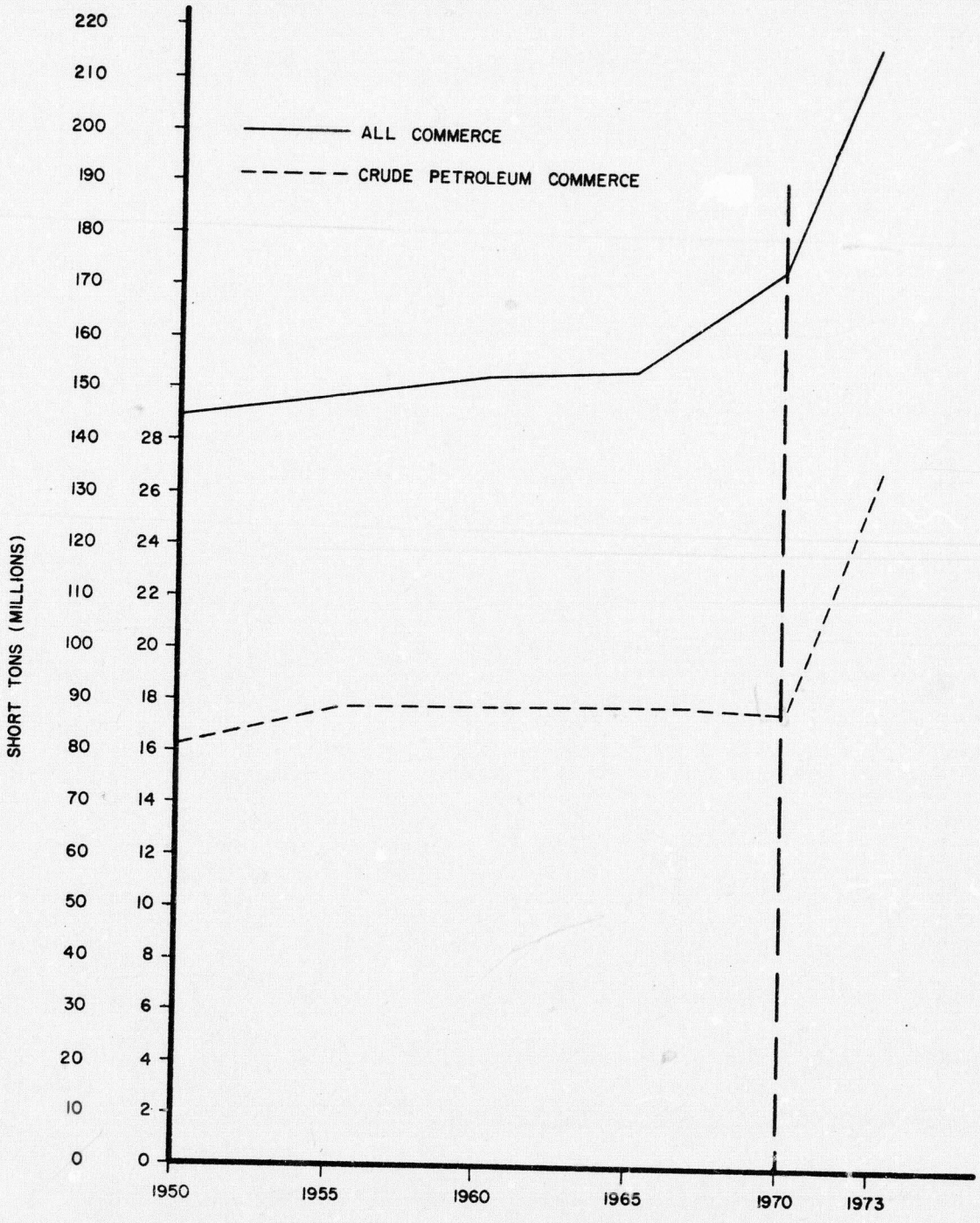

FIGURE II-61. PORT OF NEW YORK AND NEW JERSEY

FREIGHT TRAFFIC TRENDS

(Source of Data: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973)

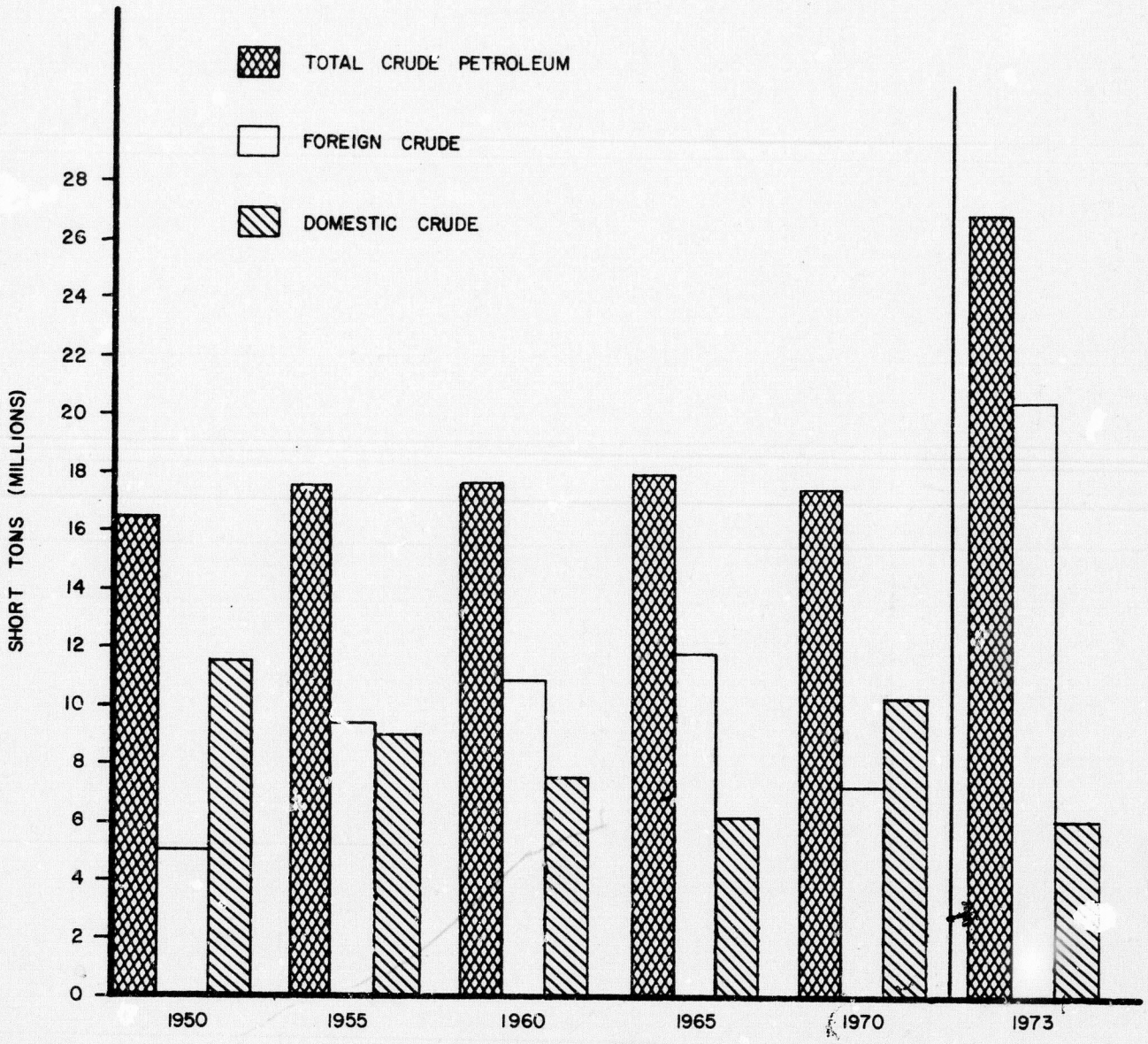

FIGURE II-62. PORT OF NEW YORK AND NEW JERSEY

CRUDE PETROLEUM TRENDS

(Source of Data: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973)

Domestic crude volume within the harbor declined proportionately until 1970 when it reached 59 percent. It was the only other time during the five-year intervals that domestic shipments accounted for a greater proportion of crude tonnage than foreign freight. Domestic crude oil production also reached its peak in 1970. In 1973, crude petroleum totalling 26,483,182 short tons represented 17 percent of all petroleum product shipments through the port. Petroleum shipments play a major role in bulk commodities, but the port's emphasis on foreign oceanborne general cargo is expected to continue.

Delaware River

The Delaware River Port, which encompasses the Delaware River from Trenton, New Jersey, to the Capes, is the second largest harbor area of the region based upon its total cargo for 1973. It is located to the northwest of the mid to lower segments of the leasing area as depicted in Visual 5. In 1973, slightly less than 30 percent of all freight traffic handled by the region's major harbors was handled through this port complex. Delaware Bay, the main entrance to the harbor along the River, has a natural depth of 50 feet for five miles through the Capes. The project depth through the remainder of the Bay and up the River is 40 feet. The entrance to the Delaware Bay as directed traffic areas, each having inbound and outbound lanes. A detailed description of these lanes appears in Appendix 8 . Other heavy traffic areas are not described; only officially designated lanes appear in the appendix.

There are a number of deep draft wharves and piers along the Delaware River, many of which have direct highway and railroad connections, water and electrical shore power. There are many specialized bulk cargo facilities which are utilized in the loading and unloading of petroleum products. Major petroleum handling facilities are located at Paulsboro, Marcus Hook, Camden, Philadelphia, Wilmington, Claymont, and Delaware City; most of these facilities are privately owned.

The volume of freight in the Delaware River has steadily increased over the past twenty years with an ensuing increase in the number of vessels entering and leaving the harbor area. Between 1950 and 1970, the volume of harbor traffic from Trenton to the sea increased by 80 percent or 54,894,599 short tons. Although there was an actual increase of 18,704,826 short tons in crude volume, proportionally it remained at approximately the same level, between 38 and 45 percent of all commerce. Table II-79 and Figure II-63 show actual crude tonnage through the port during selected years. Figure II-64 compares domestic and foreign crude petroleum commerce.

Unlike the Port of New York and New Jersey during the time period examined, foreign crude shipments have almost always accounted for a greater percentage of crude freight than domestic crude shipments. There was a greater proportion of domestic crude as compared to foreign crude petroleum imports in 1970 only. Domestic crude out-

Table II- 79. Delaware River Port Freight Traffic (Short Tons)

Year	Total Tonnage (TT)	Crude Petroleum Tonnage					
		Total Crude (TC)		Foreign		Domestic	
		Tons	Percent of TT	Tons	Percent of TC	Tons	Percent of TC
1950	69,080,525	30,743,789	44.5	17,989,002	58.5	12,754,787	41.5
1955	86,858,624	38,335,332	44.1	21,564,728	56.3	16,770,604	43.7
1960	99,844,544	40,808,146	40.9	22,230,345	54.5	18,577,801	45.5
1965	107,315,410	41,036,695	38.2	23,948,353	58.4	17,088,342	41.6
1970	123,975,124	49,448,615	39.9	21,028,622	42.5	28,419,993	57.5
1973	139,297,118	57,319,810	41.1	43,994,456	76.8	13,325,354	23.2

(Source: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973.)

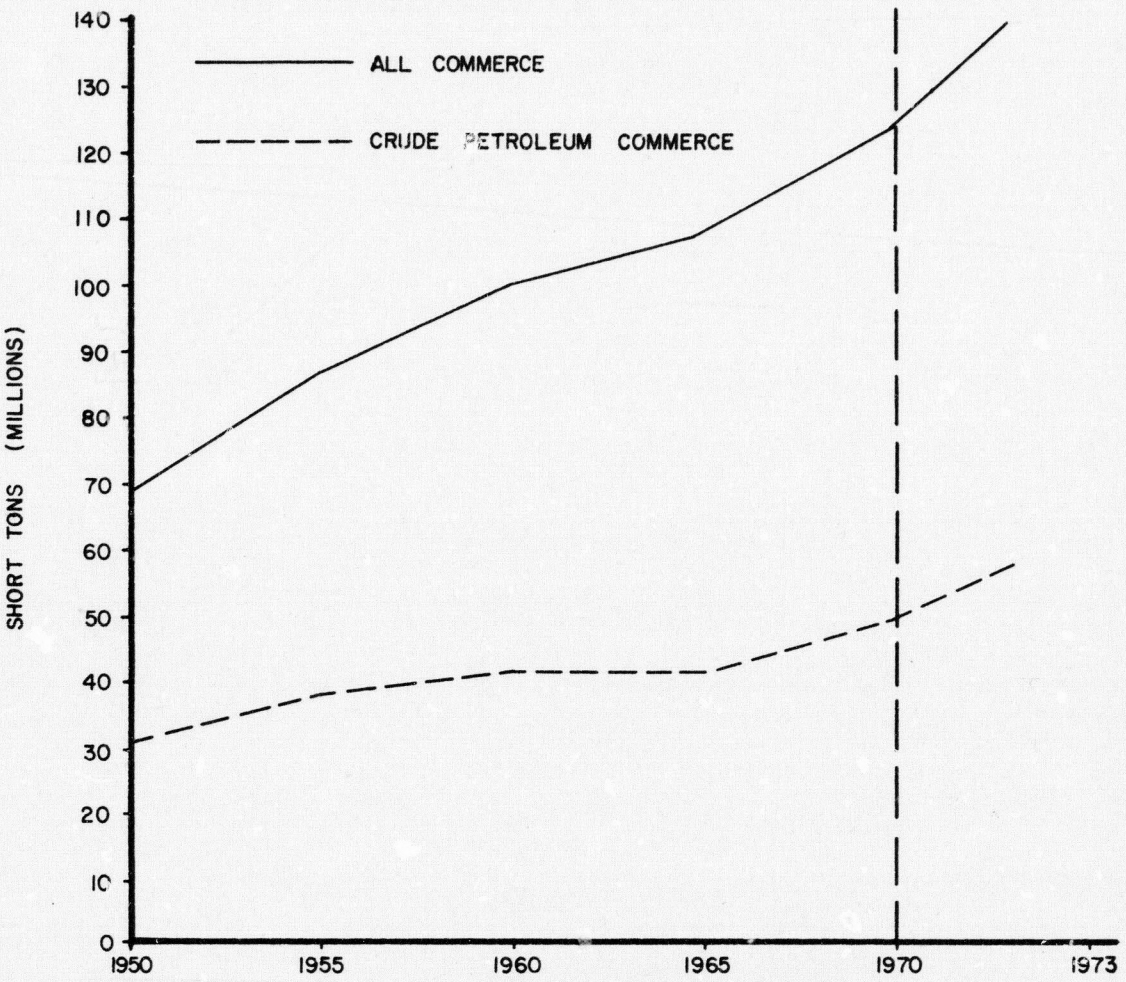

FIGURE II-63. DELAWARE RIVER PORT

FREIGHT TRAFFIC TRENDS

(Source of Data: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973)

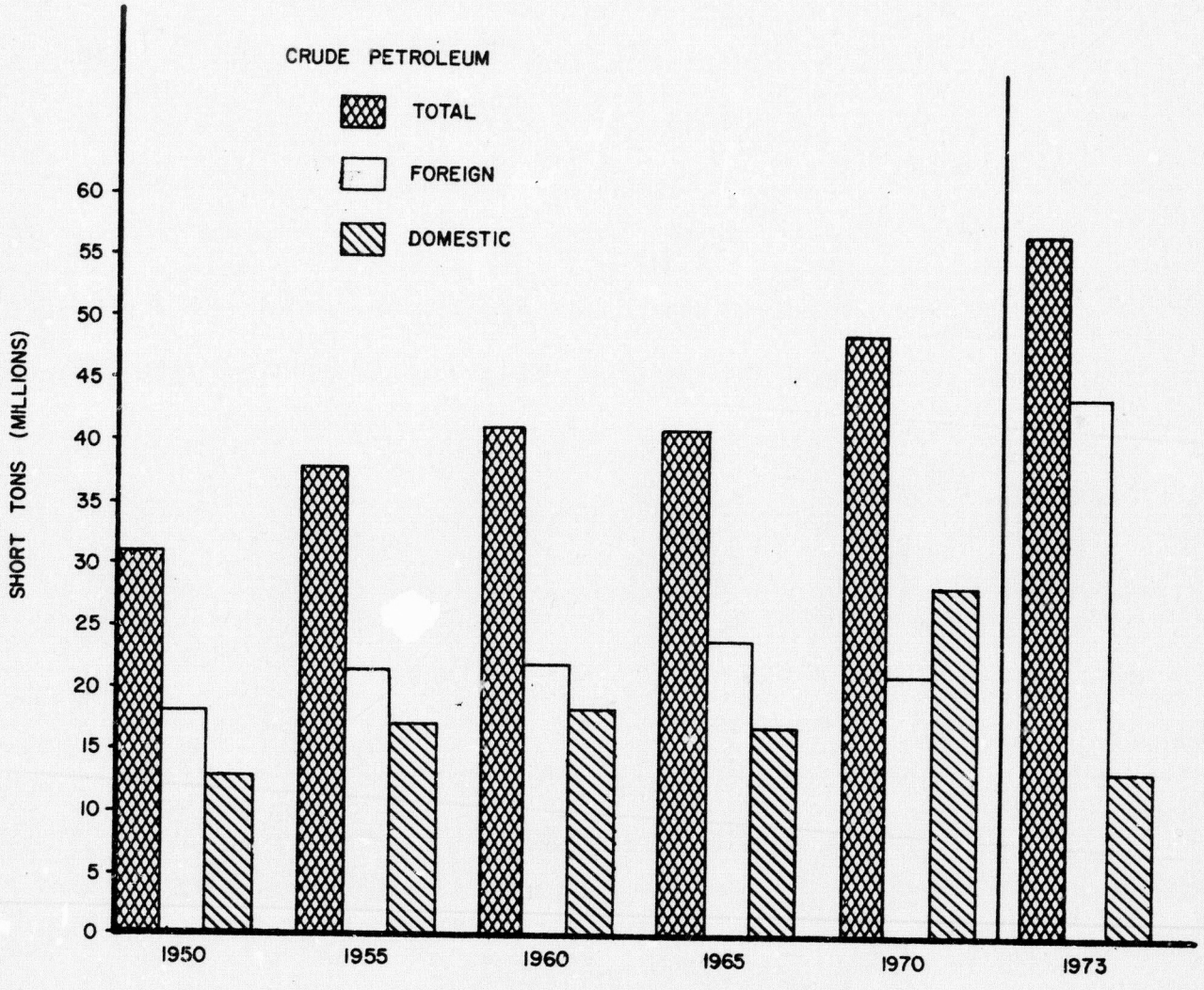

FIGURE II- 64. DELAWARE RIVER PORT

CRUDE PETROLEUM TRENDS

(Source of Data: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973)

weighed imported crude in 1970 by 35 percent or 52,430,320 barrels, amounting to 58 percent of total crude tonnage. Between 1970 and 1973, there was a sharp decline in domestic shipments of crude petroleum and an accompanying increase in foreign crude commerce. Seventy-seven percent of all crude cargo coming through the harbor in 1973 was from foreign sources, as compared to 43 percent in 1970.

Baltimore Harbor

Baltimore Harbor is located to the northwest of the southernmost tip of the proposed leasing area. It is the fourth largest port in the nation both in terms of total tonnage and value of its commerce. To enter the harbor from the Atlantic, vessels must either go through the Virginia Capes (to the south of the proposed leasing area), north through Chesapeake Bay, and north to Patapsco River; or through the Delaware Bay, north to the Chesapeake and Delaware Canal, west to Chesapeake Bay, and south to the Patapsco River entrance to the Harbor. While project depths within Baltimore Harbor are presently 42 feet, Congress has already authorized a new project depth of 50 feet. Until the problem of dredge spoil disposal is resolved, the channels will not be dredged to the newly authorized depths.

There are more than 200 piers and wharves in Baltimore Harbor. Most of these facilities have direct highway connections and many have direct rail connections. At most piers and wharves, water

and electrical shore power connections are available. Many specialized bulk commodity facilities which handle petroleum products already exist in the Port. During 1973, 53,786,715 short tons of cargo were handled through the Port of Baltimore. Bulk cargo represented a major portion of this total. Through the twenty year period between 1950 and 1970, port shipments increased by 43 percent. Unlike crude shipment trends in the previous ports discussed, crude tonnage continually decreased until 1970. During that time there was an 82 percent drop in total crude volume from a 1950 high of 3,200,976 short tons. Table II- 80 is a depiction of these trends. The volume of foreign crude decreased by 58 percent, but it increased proportionately from 37 percent of all crude in 1950 to 93 percent in 1973. Figures II- 65 and II- 66 represent crude petroleum trends in the harbor.

Hampton Roads

Hampton Roads is located to the southwest of the proposed leasing area. It includes Norfolk Harbor and the Port of Newport News and encompasses the cities of Norfolk, Portsmouth, Chesapeake, Newport News, and Hampton. Hampton Roads is considered the world's foremost bulk cargo harbor. Vessels in the Atlantic can enter the port of Hampton Roads from the Chesapeake Bay, which has a traffic separation scheme that is described in Appendix 8. The main part of Hampton Roads has natural depths which range from 80 to 20 feet.

Table II-80. Baltimore Harbor Freight Traffic (Short Tons)

Year	Total Tonnage (TT)	Crude Petroleum Tonnage					
		Total Crude (TC)		Foreign		Domestic	
		Tons	Percent of TT	Tons	Percent of TC	Tons	Percent of TC
1950	35,640,406	3,200,976	9.0	1,189,728	37.2	2,011,248	62.8
1955	45,823,878	3,019,044	6.6	1,086,504	36.0	1,932,540	64.0
1960	43,419,627	929,358	2.1	775,625	83.5	153,733	16.5
1965	44,267,160	671,875	1.5	556,559	82.8	115,316	17.2
1970	51,084,394	589,070	1.1	500,010	84.9	89,060	15.1
1973	53,786,715	900,469	1.7	835,705	92.8	64,764	7.2

(Source: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973.)

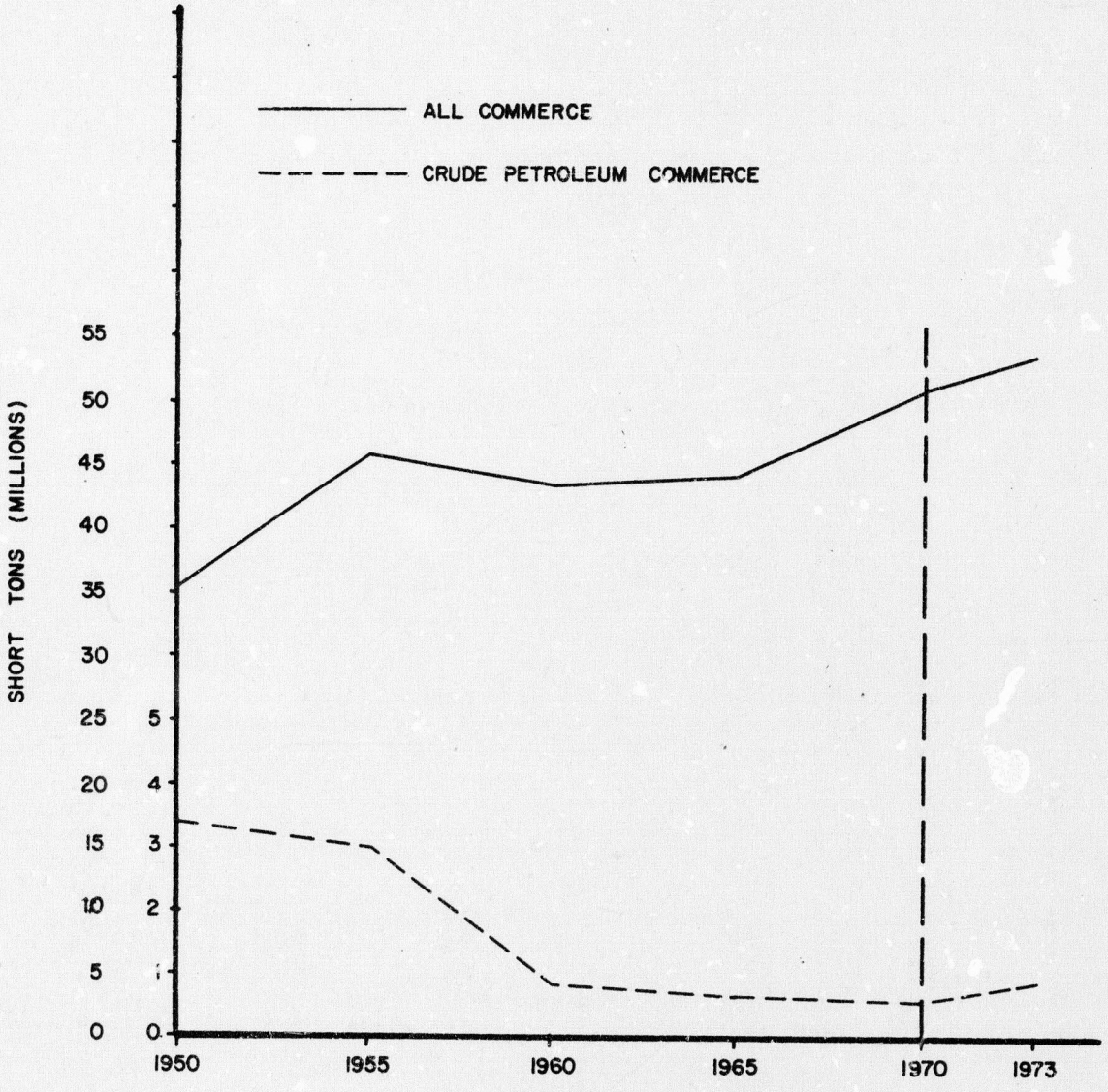

FIGURE II - 65. BALTIMORE HARBOR
FREIGHT TRAFFIC TRENDS

(Source of Data: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973)

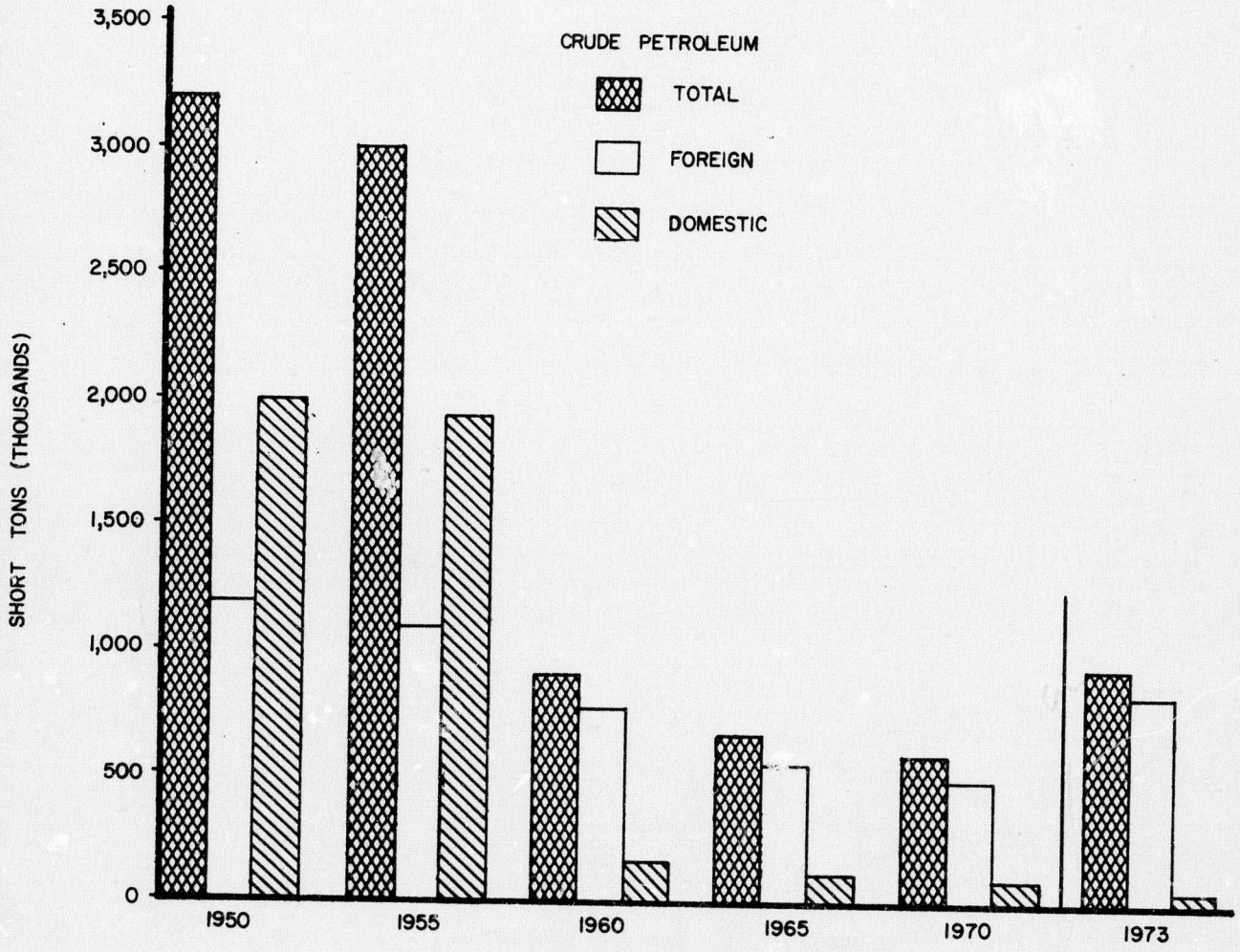

FIGURE II- 66.

BALTIMORE HARBOR

CRUDE PETROLEUM TRENDS

(Source of Data: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973)

The project depth in the main Hampton Roads channels is 45 feet.

There are more than 30 miles of improved waterfront having over 200 piers and wharves, most of which are privately owned. Petroleum handling and bunkering facilities exist in both Norfolk Harbor and the Port of Newport News. Highway and rail access, fresh water connections, and electric shore power connections are available in the harbor. Tonnage handled in the port showed an overall increase from 1950 to 1970. Table II-81 and Figure II-67 depict these trends. In 1973, 63,963,750 short tons of commerce came through Hampton Roads, a decline of 11 percent from the 1970 total. Crude petroleum and petroleum products accounted for only 6 percent of all commerce, 97 percent of which was petroleum products. Figure II-68 represents both foreign and domestic crude petroleum freight. Sixty-one percent of the crude passing through the harbor during 1973 was from foreign shipments.

c. Land and Air Transportation

Major transportation facilities, discussed below, are shown on Visual 5. A general discussion of these transportation facilities on the Atlantic coast is included in the Final EIS for the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol. 1, pp. 485-488.

Highways

The main transportation artery in the Mid-Atlantic region is between New York City and Washington, D.C. This corridor is amply served by major highways. Interstate 95 follows this corridor and

Table II- 81. Hampton Roads Freight Traffic (Short Tons)

Year	Total Tonnage (TT)	Crude Petroleum Tonnage					
		Total Crude (TC)		Foreign		Domestic	
		Tons	Percent of TT	Tons	Percent of TC	Tons	Percent of TC
1950	29,235,152	--	--	--	--	--	--
1955	56,803,753	17,577	0.03	--	--	17,577	100.0
1960	49,955,853	175,144	0.4	139,248	79.5	35,896	20.5
1965	54,105,576	249,425	0.5	249,425	100.0	--	--
1970	71,490,389	121,298	0.2	--	--	121,289	100.0
1973	63,963,750	486,868	0.8	298,149	61.2	188,719	38.8

(Source: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973.)

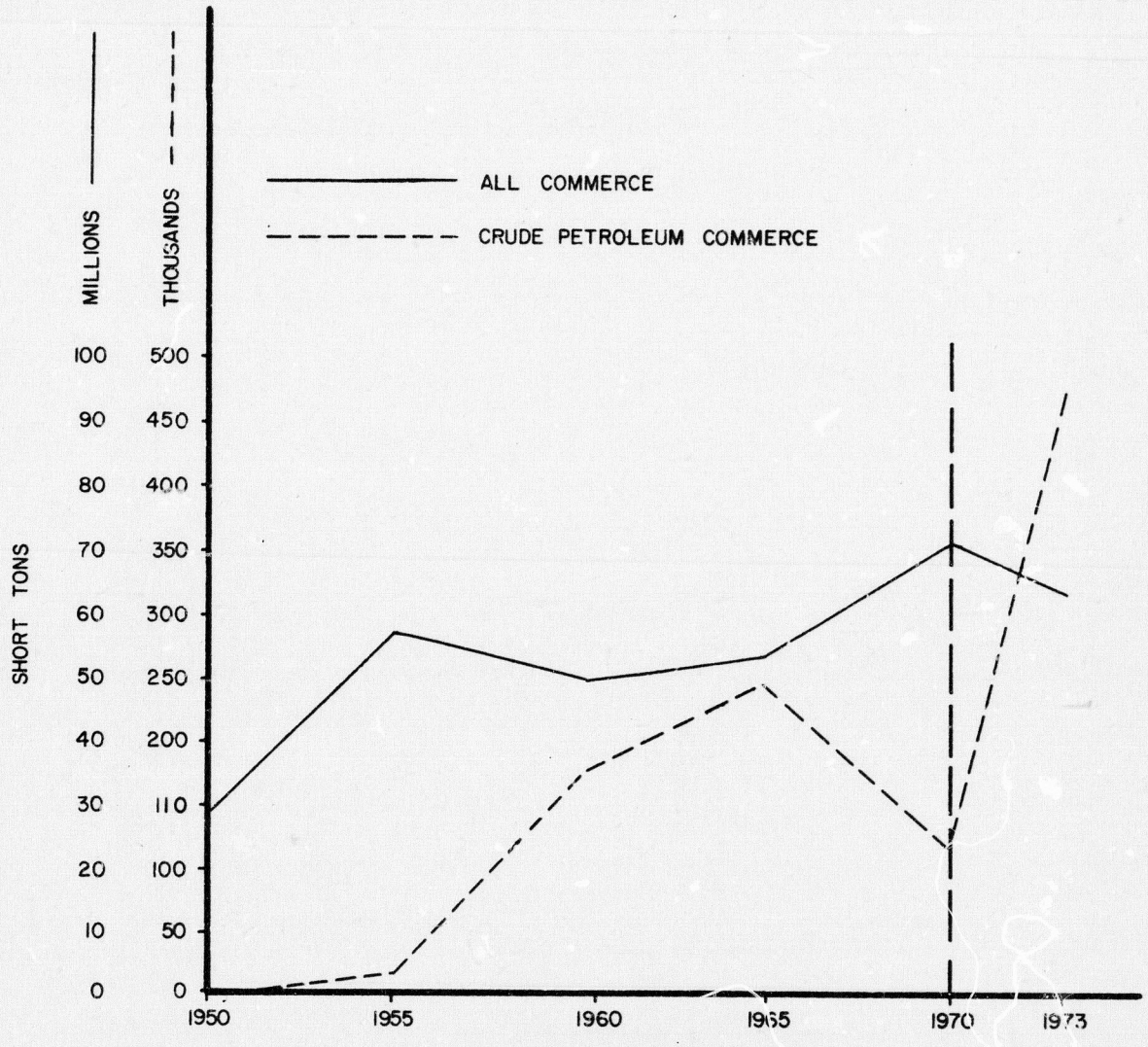

FIGURE II- 67. **HAMPTON ROADS**

FREIGHT TRAFFIC TRENDS

(Source of Data: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973)

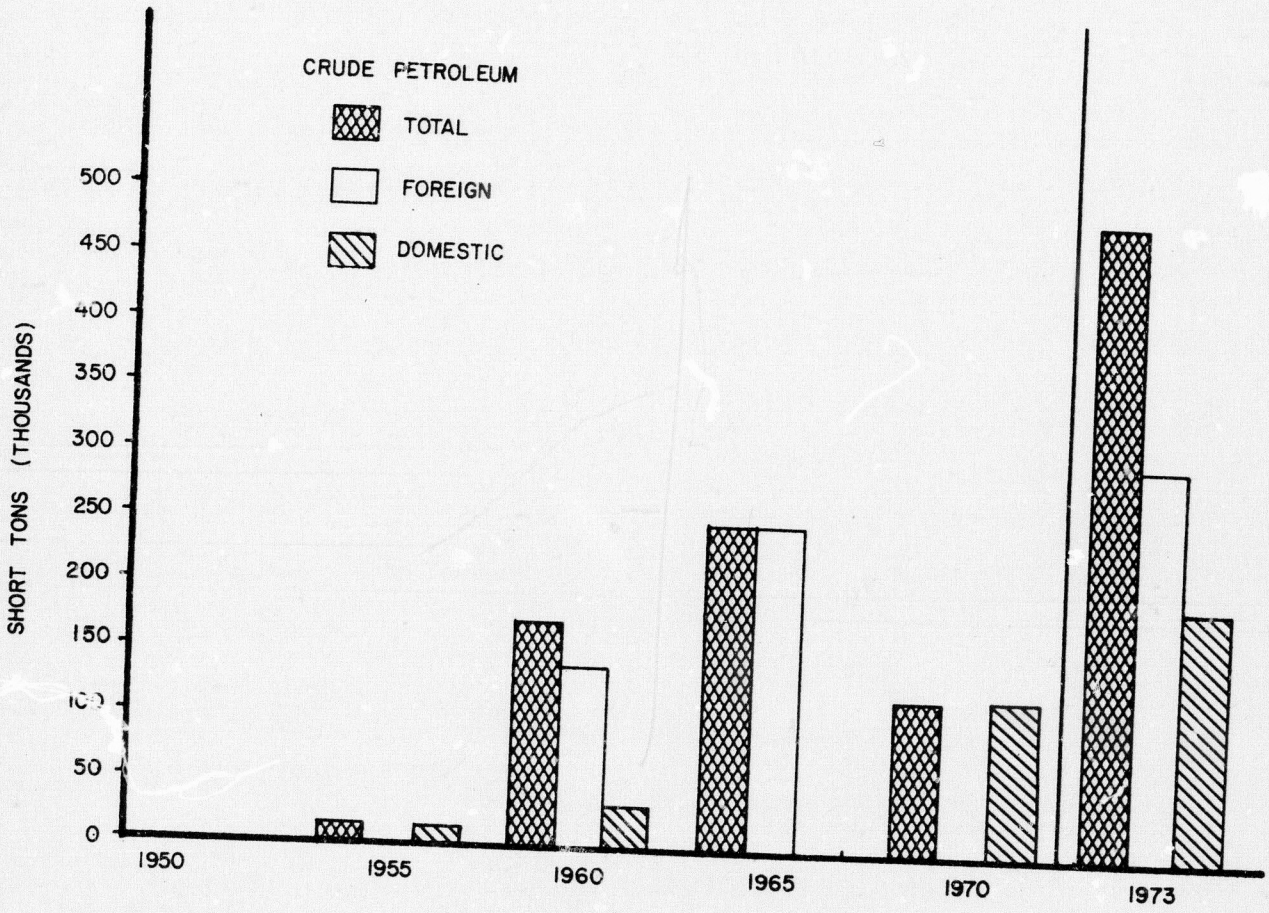

FIGURE II- 68.

HAMPTON ROADS

CRUDE PETROLEUM TRENDS

(Source of Data: Waterborne Commerce of the United States. U.S. Army Corps of Engineers, 1950, 1955, 1960, 1965, 1970, 1973)

is paralleled by U.S. Route 1, the New Jersey Turnpike, part of U.S. 40 and the Baltimore-Washington Expressway. Norfolk, Virginia is connected to I-95 by I-64, through Richmond.

Coastal north-south routes are also served by major divided highways, including the Garden State Parkway in New Jersey, and U.S. Route 13 on the Delmarva Peninsula. Connections between the coastal areas and the major north-south arteries are fairly good, but no major divided highways serve parts of the region. Major connecting routes include the Chesapeake Bay Bridge-Tunnel, connecting the southern tip of the Delmarva Peninsula with Norfolk, Virginia; U.S. Route 50, connecting the Maryland Eastern shore with Annapolis and Washington; State Route 14 in Delaware, connecting the shore area; and the Atlantic City Expressway, connecting Atlantic City with Philadelphia.

In terms of major highway access to industrial and metropolitan areas, the following areas are the least well served: coastal areas of Salem and Cumberland Counties in New Jersey; the area between the Rappahannock and Potomac Rivers and Mathews County in Virginia; and parts of the Maryland eastern shore on the Bay side, especially coastal areas of Dorchester and Kent Counties.

While major highways are extensive and service most of the region, as discussed above, the level of capacity at which they operate

varies. Many of the major arteries, particularly in and around the urban areas and at peak times, presently operate at congested levels. A discussion of secondary roads will not be made here, however, the adequacy of secondary road systems varies by specific locality, with significant deficiencies in some areas. For example, many of the roads between the New Jersey mainland and barrier islands are presently very congested, particularly during the summer months.

Railroads

The major rail corridor in the Mid-Atlantic region also stretches between New York City and Washington,D.C., and extends to the Hampton Roads area through Richmond, Virginia. Both passenger and freight service are provided in this corridor. The other long-haul freight route extends from Wilmington, Delaware, to Cape Charles, Virginia, where freight car ferry service has been provided to Norfolk.

The major rail operator in the region is the new Consolidated Rail Corporation (Conrail), which recently acquired and took over operation of several bankrupt rail lines. Important exceptions are solvent private railroads serving areas south of Washington, D.C.[1] Previous to the formation of Conrail, Bankrupt Class I railroads in the Northeast (ICC Eastern District) carried 46 percent of the area's ton mile freight volume in 1972. The Regional Rail Reorganization

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[1]Such as the Southern Railroad

Act of 1972 (P.L. 93-236) mandated creation of the Consolidated Rail Corporation (Conrail) with the aim of consolidating economically viable routes in a government assisted system, with provisions for selling parts of bankrupt lines to solvent lines and providing interim subsidies for some local rail services not included in the system. After a long and complex planning process, the U.S. Railway Association's Final System Plan was present to Congress on July 26, 1975, and has since been implemented.

Major elements of the Final Plan affecting long-haul freight routes in the Mid-Atlantic region are: (1) Conrail acquisition of trackage and trackage rights, and operation of lines in the corridor between New York and Washington; and (2) offering for sale to the Southern Railroad the entire route servicing the Delmarva Peninsula. However, the potential acquisition of this route by the Southern Railroad is uncertain at this time. Service between the New York City area and Cape May County, New Jersey, is also eliminated under the Plan. Connecting lines from the New York City area are operated by Conrail to points in northern New Jersey, and connections are operated from the Philadelphia area to southern New Jersey. There is no Conrail operated connecting service in Delaware or the Maryland-Virginia Eastern Shore.

The Final System Plan also proposed Amtrak acquisition of lines on the corridor between New York and Washington. Service had previously

been provided in this corridor by Amtrak, although Amtrak did not own the trackage. Amtrak service is also provided to Newport News and Norfolk, Virginia, via Richmond. Other passenger service in the region serves primarily commuters. In addition, rail service to New Jersey shore areas is provided from the Philadelphia and New York areas.

Public Mass Transit

Public mass transit in the Mid-Atlantic region is almost exclusively found in the major metropolitan areas. Commuter service via rail and bus to suburban areas is provided by some metropolitan transportation authorities, and in most cases is supplemented by private rail and bus lines. A new transit system utilizing the medians of arterial highways is under construction in the Baltimore region. Even in heavily populated suburban counties, public transit is limited almost exclusively to commuter routes into the major cities, with no intracounty service. Non-commuter intracounty and intercounty non-auto transit is provided by commercial bus lines.

Despite existing mass transit systems, the region, including the metropolitan areas, is still heavily dependent on the automobile. For example, it is estimated that of the commuter traffic between New Jersey and Manhattan, slightly less than half is via some form of public transportation.

Air

The Mid-Atlantic region is well served by major airports. At least one major airport services each of the following cities: New York, Newark, Philadelphia, Baltimore, Washington, D.C., Newport News, Richmond, and Norfolk. Additional scheduled flights are found at airports in the following areas: Long Island; Monmouth, Atlantic, Cape May, and Mercer Counties in New Jersey; Wicomico County, Maryland, and Wilmington, Delaware. All coastal counties with the exception of Nassau County, New York, are served by at least one general aviation airport.

Seaplane bases are located on Long Island and in the New York City area, as well as near Wilmington, Delaware. Heliports in the region are limited to Manhattan, coastal Monmouth County, New Jersey, Dover, Delaware, and Cecil County, Maryland.

d. Shore[1] Use and Ownership

The use of the shore for recreation and open space purposes predominates on the Atlantic Coast from Montauk Point at the eastern end of Long Island, New York, to Cape Charles at the southern end of the Delmarva Peninsula in Virginia, when the shorelines of the Delaware and Chesapeake Bays are excluded.

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[1]The relatively narrow band of land along the edge of an ocean, bay, river, or other body of water.

The only major areas where this does not hold true is the New York New Jersey Port area. When the Bays are excluded, recreation, both public and private, accounts for 48 percent of the shoreline use. Recreation use takes many forms, including: Federal, State, and local park and recreation areas; Federal, State, local, and in some instances private, wildlife preservation areas[1]; major commercial recreation facilities and resort areas; vacation home communities; and even residential areas that have an orientation to recreational use of the shore. The 1971 National Shoreline Study (U.S. Army Corps of Engineers, 1971) indicated that 405 miles, or 12 percent of the region's total shore mileage, were devoted to public recreation use. Another 189 miles, or 6 percent, were in private recreation use.

Another "use" category of this shore, seemingly a contradiction in terms, is its continuation in an undeveloped state. In spite of the fact that the region as a whole is one of the more densely populated and heavily industrialized, over 954 (28 percent) of the approximately 3,365 miles of shore are undeveloped. This observation does not appear to be such an anomaly upon closer examination of the character of these shore areas (Visual 4). Major stretches of the shore are either wetlands, barrier islands, or both. The current undeveloped state results from the interrelationship of a number of factors, some of which are discussed below. Of the Atlantic shoreline, 42 percent is undeveloped.

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[1]Many of these recreation and open space areas are shown on Visual 1.

The costs and risks associated with developing wetlands and sandy barrier islands can be very high. Moreover, in recent years concern has been growing about the destruction of these resources through development. Such concern is based upon environmental, aesthetic, and resource value reasons. The wetlands (as discussed in section II.F.2.) provide an essential habitat for numerous marine and other species. Wetlands destruction was severely curtailing the productivity of many of these species. This evolved into a very practical concern for the decline in quality of the commercial and sport marine fisheries in the region and led, in the early 1970's, to the passage of wetlands protection legislation in all of the Mid-Atlantic States.

Barrier islands have remained undeveloped in many instances because of their relative inaccessibility. This is an aspect of their uniqueness that has fostered the movement for their preservation and protection. Depending on the islands' characteristics, they provide opportunities for the preservation of the integrity of significant biological communities, for unique recreational experiences, and the preservation of an aesthetic environment conducive to the recreational use of adjacent lands.

Many of the concerns about protection and limited use of these coastal resources have resulted in State and Federal legislation. The programs and regulatory functions emanating from such legislation

were discussed in some detail in section I.F. As a result of these efforts, significant portions of these resources are having their current undeveloped status reinforced and institutionalized. Put in another perspective, that of society in a large sense, the continued nondevelopment of these resources may in fact be receiving recognition as an extremely significant use. Table II-82 (Shore Use of the Atlantic Coast--Montauk Point, New York, to Cape Charles, Virginia) gives a more detailed statistical breakdown of shore use for the region and the individaul States according to the following uses: public recreation, private recreation, nonrecreation, and undeveloped.[1]

Ownership of these shore resources reflects, and in some respects probably reinforces, the use patterns discussed above. Federal and other public ownership totals 718 miles or 21 percent of the total. For the Atlantic shoreline only, total public ownership is 51 percent. The majority of the Federally-owned lands is allocated to recreation and/or fish and wildlife uses. Recreation use will be discussed in some detail in subsection e. below.

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[1] These four categories were formulated by the U.S. Army Corps of Engineers for use in their 1971 National Shoreline Study.

Table II-82. Shore Use of the Atlantic Coast--Montauk Point, New York, to Cape Charles Virginia

	VIRGINIA[1]		MARYLAND[2]		DELAWARE[3]		NEW JERSEY[4]		NEW YORK[5]		REGION	
	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%
PUBLIC RECREATION	50	5	105	5	30	28	163	78	57	48	405	12
PRIVATE RECREATION	56	6	111	6	2	2	10	5	10	9	189	6
NONRECREATION	155	15	1,623	84	3	3	2	1	34	29	1,817	54
UNDEVELOPED	732	74	100	5	71	67	34	6	17	14	954	28
TOTAL LENGTH OF SHORE	993	100	1,939	100	106	100	209	100	118	100	3,365	100

[1] Includes 239 miles of Atlantic Shore and 754 miles of Chesapeake Bay Shore.

[2] Includes 31 miles of Atlantic Shore and 1,908 miles of Chesapeake Bay Shore.

[3] From Maryland/Delaware Border to Wilmington, including Delaware Bay Shore

[4] From Sandy Hook to Penns Grove, including Delaware Bay Shore

[5] From Norton Point to Montauk Point, Atlantic Shore only

(SOURCE: 1971 National Shoreline Study, Corps of Engineers)

The nature of ownership of the shore varies from area to area. In some areas large expanses of shore are owned by a relatively few titleholders, while in others the subdivision of the land has resulted in a cumulatively small amount of shore being held by numerous titleholders. A statistical summary of land ownership by major type (Federal, other public, and private) for each of the States and the region as a whole is included in Table II-83 (Shore Ownership of the Atlantic Coast--Montauk Point, New York, to Cape Charles, Virginia).

The following pages include a somewhat more detailed discussion of shore use and ownership in each of the five Mid-Atlantic States.

The 113 miles of Virginia mainland Atlantic shore in Accomack and Northampton Counties from Cape Charles north to the Maryland border are almost totally privately owned and virtually completely undeveloped. The adjacent barrier islands total 126 miles of shore divided almost equally between windward and leeward shores. All of the islands, except Assateague, Wallops, and Fisherman, are inaccessible except by boat. There have been a few attempts at commercial development in the region in the past. Presently, however, a major effort has been undertaken to acquire and preserve the barrier islands in their natural state for perpetual protection and limited public recreation. All or part of eight islands and marshes have been acquired by the Nature Conservancy as a holding action pending public acquisition.

Table II-83. Shore Ownership of the Atlantic Coast--Montauk Point, New York, to Cape Charles, Virginia

OWNERSHIP	VIRGINIA[1] Miles	%	MARYLAND[2] Miles	%	DELAWARE[3] Miles	%	NEW JERSEY[4] Miles	%	NEW YORK[5] Miles	%	REGION Miles	%
FEDERAL	109	11	225	12	12	11	37	18	15	13	398	12
OTHER PUBLIC	115	12	35	2	31	29	96	46	43	36	320	9
PRIVATE	769	77	1,679	86	63	60	76	36	60	51	2,647	79
TOTAL LENGTH OF SHORE	993	100	1,939	100	106	100	209	100	118	100	3,365	100

[1]
[2] Includes 239 miles of Atlantic Shore and 754 miles of Chesapeake Bay Shore
Includes 31 miles of Atlantic Shore and 1,908 miles of Chesapeake Bay Shore
[3]From Maryland/Delaware Border to Wilmington, including Delaware Bay Shore
[4]From Sandy Hook to Penns Grove, including Delaware Bay Shore
[5]From Norton Point to Montauk Point, Atlantic Shore

(SOURCE: 1971 National Shoreline Study, Corps of Engineers)

The three previously referenced islands are Federally administered for recreation, activities related to the space program, and fish and wildlife activities, respectively. The State administers Wreck and Bone Island as a natural area as well as extensive wetlands that lie between the barrier islands and the mainland for wildlife management purposes.

Shorelines use along the Chesapeake Bay is largely non-recreationally developed (66 percent) and undeveloped (24 percent). Large areas along the Bay are inaccessible, especially on the western Virginia shore. There are extensive areas along the Maryland Eastern Shore devoted to Federal Wildlife Refuges and State Wildlife Areas. Areas of intensive development are concentrated in the Hampton Roads area of Virginia and the Baltimore area of Maryland. Other developed areas are primarily clusters of residential and some second home development, with Federal military uses also in the lower portion of the Virginia Bay shore. Only 10 percent of the shoreline is devoted to recreational use.

The coast of Maryland is comprised of portions of the barrier islands--Fenwick and Assateague. Ocean City, an intensely developed commercial resort, occupies the nine-mile stretch of Fenwick Island from the Ocean City inlet to the Maryland-Delaware border. The city is intensely developed with motels, apartments, restaurants, and other commercial activities typical of an ocean resort. The tourism aspects of the area are examined in subsection e. below. About three miles of the Ocean City shore are considered public recreational with the remaining six miles considered private recreational. The entire 22 mile shore of Assateague Island is considered as public recreational, 20 miles being Assateague Island National Seashore and the other two miles comprising Assateague State Park. Assateague Island is undeveloped except for

the area near the bridge, which has State and Federal camping facilities.

The Atlantic Ocean Coast of Delaware extends for approximately 25 miles from the Delaware-Maryland border at Fenwick Island northward to Cape Henlopen. Three-fourths of the shore is publicly owned. Almost two-thirds of the publicly owned lands consists of State parks and conservation areas. The fourth of the shore that is privately owned consists of residential developments around the Rehoboth Beach and Bethany Beach areas. These areas accomodate significant numbers of seasonal as well as permanent residents. Virtually the entire ocean shore is open to recreational use with the exception of the one-mile shore of a Federal military reservation. The tourism aspects of such use will be discussed in subsection e. below.

Recreational use of the 81 miles of Delaware Bay shore from Cape Henlopen north to Wilmington is not as significant. Although 30 percent of the shore is publicly owned, only slightly more than 10 percent is used for public recreational purposes. There is no private recreational development and only negligible nonrecreational development. The overwhelming majority of the shoreline (87 percent) is undeveloped, primarily because significant portions of the shoreline consist of marsh areas and poorly drained low areas with fairly extensive sections of mud flats which are exposed at low tide. Large stretches of shoreline are occupied by Prime Hook and Bombay Hook National Wildlife Refuges and several smaller wildlife areas (Visual 1).

About half of the Delaware Bay shore in New Jersey, from Penns Grove to Cape May Point, is privately owned. The remaining shore is

somewhat equally divided between Federal and other public ownership. Major portions of the shore are occupied by wildlife management areas, both State and Federal. Although much of the shoreline is listed as available for recreational use, actual use is limited because of the extensive marshes and mud flats. Nonrecreational development is negligible.

Almost three-fourths of the Atlantic shore from Cape May to Sandy Hook is publicly owned, much of it by numerous adjacent shore communities. The southern portion of New Jersey's Atlantic Coast consists of a series of barrier islands. Most of the usable land on the islands has been developed for recreationally related purposes. The beaches along the shore communities are intensively used by seasonal residents, vacationers, and day-use visitors. Major resort areas, having significant commercial facilities, are located at Atlantic City, Ocean City, and the Wildwoods.

The economic aspects of this recreational use will be discussed in subsection e. below. The shore along the northern portion of New Jersey's coast is also dedicated primarily to recreationally related uses. The adjacent areas tend to be more residential in character, however. Although there are numerous hotels and cottages for use by the seasonal population, a large percentage of the residential use is permanent.

The significance of recreational use of the New Jersey shore is made apparent by the fact that almost 90 percent of the shore is devoted to recreational use, both public and private. Approximately 10 percent of the shore is in an undeveloped state, dispersed in small parcels along the entire shore. Nonrecreational development is negligible.

The Atlantic Coast shore of Long Island, New York, from Norton Point to Montauk Point consists of a series of barrier islands, the ownership of which is divided almost equally between public and private. The public ownership is primarily local in nature, although there are six State parks and two Federal parks (Gateway National Recreation Area and Fire Island National Seashore).

The nature of the ownership, coupled with the superb quality of the beach resources, account for the fact that almost three fifths of the shoreline is dedicated to recreation use, primarily public. The many fine parks and beaches accommodate the tremendously large day use demands of the metropolitan New York area. Residential use, both seasonal and permanent, occupies significant stretches of shore. Consequently, almost one-third of the shore is occupied by this and other nonrecreational development. Undeveloped shore amounted to approximately 14 percent of the total shore mileage in 1971, but increasing demands are being placed upon these remaining areas by residential growth pressures.

An overview of land ownership along the entire Atlantic coastline is found in the Final EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol. 1, pp. 446-447.

e. Recreation and Tourism

Recreation Resources

The recreational resources discussed in this section are primarily water-related and coastal oriented. Water-related recreational activities are composed of both water-dependent and water-enhanced activities. For the former, such as swimming, boating, fishing, and waterfowling[1], the quality of the water and surrounding environs, as well as its accessibility, are essential ingredients. For the latter, however, a quality water environment is positive reinforcement to the activities but is not essential to their undertaking. Examples of such water-enhanced activities are camping, picnicking, and nature interpretation.

The demand for (or desire to participate in) water-related recreational activities ranks high among the demand for all recreational activities in the Mid-Atlantic States. Table II-84 indicates the relative ranking of seven of the more popular water-related activities in these states. The table also includes the projected percentages of increase in demand for those activities which can be expected over a given timeframe[2]. The water-dependent activities, swimming,

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[1]Waterfowling refers to hunting waterfowl.

[2]The statistical material presented in this and subsequent discussions of recreation are drawn from the Statewide Comprehensive Outdoor Recreation Plans (SCORP) of the respective states. Although each SCORP is prepared in accordance with the requirements of the Land and Water Conservation Fund Act of 1965, methodologies employed by the various states result in data that may not be completely comparable. Recognizing the inherent limitations of this data, it is displayed only for the purpose of very generalized discussions.

TABLE II-84. RANKING OF WATER-RELATED RECREATIONAL ACTIVITIES WITHIN THE FIVE MID-ATLANTIC STATES BY RELATIVE POPULARITY AND PERCENT INCREASE ANTICIPATED BY 1990/2000

	Virginia		Maryland		Delaware		New Jersey		New York	
	Rank	% Change	Rank	% Change	Rank	% Change	Rank	% Change	Rank	% Change
Swimming	7[1]	66	7[2]	144	1	75	1	110	1	130
Fishing	6	31	9	45	6	2	7	N.A.	6	114
Boating	9	67	10	116	4	79	8	116	7	128
Picnicking	8	44	4	72	5	28	5	N.A.	2	123
Camping	14	75	15	119	10	101	14	161	8	122
Hunting	22[3]	17	13	48	11	-12	15	N.A.	9	109
Nature Walking	3[4]	70	11	78	N.A.	N.A.	10	N.A.	N.A.	N.A.
Total Activities Ranked	24		21		13		23		12	
Time Frame	1972-1990		1970-1990		1960-2000		1970-2000		1970-1990	

[1]Beach Use
[2]Beach Swimming Only
[3]Waterfowling Only
[4]Includes Hiking
N.A. - Not Available in the Respective Scorps

(Source: Statewide Comprehensive Outdoor Recreation Plans For The Respective States)

fishing and boating, rank within the top half of all activities within each of the respective states except New York. In New York swimming and fishing rank within the top half but boating is seventh out of the twelve ranked activities on a Statewide basis. However, the availability of Long Island coastal resources makes boating the third in popularity in that area. Swimming is ranked highest of the water-dependent activities in all of the States except Virginia where it is ranked just behind fishing. The demand to participate in swimming is not only large, but it is also projected to grow at a very rapid rate. Although the timeframe used as a basis of measurement differs for each of the States, it can be roughly estimated that demand for swimming will increase from a low of 66 percent in Virginia to a high of 144 percent in Maryland, between now and 1990. Of the water-enhanced activities, picnicking ranks higher than the others in all five States. The demand for camping, while not presently ranked very high, is projected to increase very dramatically during the next two decades.

The National Marine Fisheries Service of the National Oceanic and Atmospheric Administration conducts periodic surveys to determine the magnitude of participation in saltwater recreational activities. Table II-85 summarizes the results of a survey conducted in June 1974. It lists the number of households in each of the five Mid-Atlantic States which had at least one member participating in one of the seven enumerated saltwater recreational activities during the preceeding twelve months. More than four and one-half million households in the five-state region participated in saltwater swimming.

TABLE II-85. HOUSEHOLDS PARTICIPATING IN MARINE RECREATIONAL ACTIVITIES BY STATE OF RESIDENCE[1]

STATE OF RESIDENCE	SWIMMING	SAILING	PLEASURE BOATING	FIN FISHING	SHELL FISHING	BEACHCOMBING
New York	2340	487	997	1290	338	1040
New Jersey	1110	262	487	737	234	589
Delaware	81	15	45	58	29	48
Maryland	508	110	288	397	157	285
Virginia	523	122	278	432	136	325
Totals	4562	996	2095	2914	894	2287

[1] In thousands of households for the period from mid-June 1973 to mid-June 1974. Numbers indicate at least one person per household participated in activities listed.

(SOURCE: Statistics and Market News Division, National Marine Fisheries Service)

Almost three million households participated in finfishing. For each of the seven activities, the participation generated by New York and New Jersey residents together equaled two-thirds to three-fourths of the regional totals. The information in the table is only displayed by state of residence of the participating household and consequently, the areas where the activities took place are not determinable. Nevertheless, the survey does provide a basic look at the magnitude of interest in saltwater recreational activities in these five Mid-Atlantic States. More detailed information on marine recreational fishing is included in section II.G.1.f.

The statistics in Table II-84, along with the preceeding discussion, give only a generalized view of the relative significance of water-related recreation activity. Its applicability to the coastal area is limited because the figures are generated from statewide statistical analyses. Additionally, the statistics for water-dependent activities include all forms of swimming, fishing, and boating and not just those dependent on the use of coastal waters. The statistics for the water-enhanced activities do not differentiate, quantitatively, those activities which actually are undertaken adjacent to water, coastal or otherwise. Consequently, the succeeding discussion will draw from the statewide data and, where possible, apply it to the coastal areas of the respective states. Where available, specific information and data are supplied for the major Federal and State recreation areas displayed on Visual 1.

There are twelve Federal coastal recreation areas[1] from Montauk Point on the eastern tip of Long Island, New York, to Cape Charles at the southernmost tip of the Delmarva Peninsula in Virginia (Figure II- 69). Table II-86 lists the individual areas and provides information on the primary recreation activities which they accommodate, their size, location, and annual visitation figures for 1974. The areas administered by the National Park Service (Fire Island, Gateway, and Assateague Island) receive significantly higher visitation rates than the National Wildlife Refuges. Wildlife refuges are not established primarily to provide recreational opportunities, and facilities are not developed to encourage active recreation use. While visitation at the wildlife refuges is somewhat modest in comparison with major Federal recreation areas, the refuges remain an important source of qualitative, if not quantitative, recreational opportunity. The major exception to this is the Chincoteague National Wildlife Refuge which, because of its accessibility from the Baltimore-Washington metropolitan area and its proximity to the Assateague Island National Seashore, receives annual visitation in excess of one million persons.

Gateway National Recreation Area (NRA) received the greatest number of visitors on an annual basis--in excess of four million visits during 1974. Gateway's proximity to the large New York-New Jersey metropolitan area, coupled with the qualitatively significant

[1]National Wildlife Refuges, while not established primarily as recreation areas, receive significant recreation use and, consequently, are addressed in this section in that context.

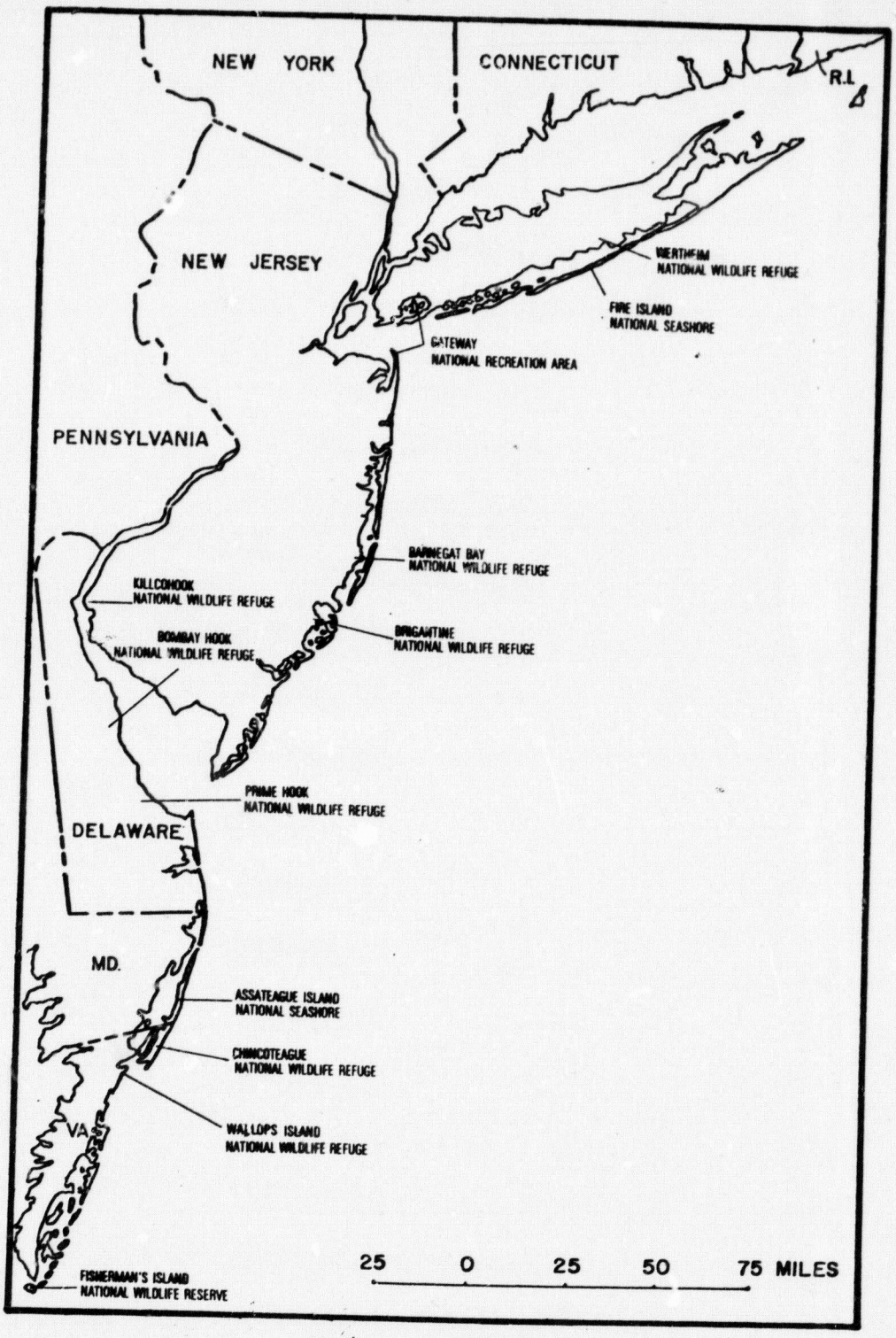

FIGURE II-69. **MID-ATLANTIC REGION**

TABLE II-86. Federal Recreation[1] Areas

Montauk Point, New York, To Cape Charles, Virginia

FACILITY	Location	Acres	Primary Activities	Annual Visitation 1974[2]
Fire Island National Seashore	New York	(Acres Authorized) 119,311[3]	Swimming, Fishing, Nature	550,400
Wertheim National Wildlife Refuge	New York	2,149	Not Open For Public Use	-
Gateway National Recreation Area	New York-New Jersey	19,485 (27,000)	Swimming, Fishing, Wildlife Observation And Interpretation	4,111,400
Barnegat Bay National Wildlife Refuge	New Jersey	3,328	Fishing, Wildlife Observation	4,140
Brigantine National Wildlife Refuge	New Jersey	19,527	Wildlife Interpretation And Observation, Fishing, Waterfowling	151,705
Killcohook National Wildlife Refuge	New Jersey	650 (4,000)	Wildlife Observation And Interpretation, Waterfowling, Hunting	Reported Together With Bombay Hook Statistics Below
Bombay Hook National Wildlife Refuge	Delaware	15,110	Wildlife Observation And Interpretation, Waterfowling, Hunting	61,466
Prime Hook National Wildlife Refuge	Delaware	6,875 (10,000)	Wildlife Observation, Fishing, Waterfowling Hunting	25,529
Assateague Island National Seashore	Maryland-Virginia	25,000 (40,000)[4]	Swimming, Nature Interpretation, Camping	1,714,400
Chincoteague National Refuge	Virginia	9,439	Wildlife Observation And Interpretation, Picnicking, Fishing, Camping, Swimming, Hunting	1,150,780
Wallops Island National Wildlife Refuge	Virginia	3,000[5]	Not Open For Public Use	-
Fisherman's Island National Wildlife Refuge	Virginia	1,000	Wildlife Observation And Interpretation	596

[1]National Wildlife Refuges, while not established primarily as recreation areas, receive significant recreation use and, consequently, are addressed in this section in that context.

[2]Sources: National Park Service and Fish and Wildlife Service, U.S. Department of the Interior

[3]Includes 16,577 acres under local ownership.

[4]Includes Chincoteague NWR and Assateague State Park.

[5]Administered under a Cooperative Management Agreement with NASA.

recreation opportunities which it offers, accounts for the visitation. Fire Island National Seashore's visitation was just in excess of half a million in 1974. The area was only relatively recently established and work on the park's master plan is still underway. When the facilities proposed in the plan are developed and their availability becomes more widely known, visitation at the Fire Island NS can be expected to increase markedly. Visitation at the Assateague Island NS was approximately 1.7 million during 1974, down from the more than two million total of the previous year. The decrease can probably be attributed to the uncertainty in gasoline supplies during last summer. With the stabilization of the gasoline supply, visitation will probably return to a two million plus figure.

Many of the marsh areas along the coast of the Mid-Atlantic region, whether or not actively managed by Federal or State governments as wildlife areas, serve as feeding and resting areas for a number of migratory bird species that frequent the Atlantic Flyway. These areas support waterfowl populations to satisfy major portions of waterfowling demand in these states. The individual state SCORP's with the exception of Virginia's, do not break waterfowling demand out of total hunting demand. The information displayed in Table II-87, taken from surveys of the Office of Migratory Bird Management of the U.S. Fish and Wildlife Service, provides data on waterfowling activity in the Mid-Atlantic States for the period 1971-1974.

TABLE II-87. TOTAL DUCK STAMP SALES AND HUNTER DAYS FOR THE MID-ATLANTIC STATES, 1971-1974[1]

STATE	1971		1972		1973		1974	
	STAMPS	DAYS	STAMPS	DAYS	STAMPS	DAYS	STAMPS	DAYS
New York	116.4	673.3	103.5	622.1	104.9	626.3	80.7	455.6
New Jersey	43.7	258.9	36.0	210.5	35.2	212.6	33.0	219.9
Delaware	13.0	100.0	11.5	91.2	13.1	107.2	11.4	93.8
Maryland	32.6	263.0	30.7	239.4	33.8	273.6	36.3	298.7
Virginia	19.8	123.8	20.7	131.5	19.0	123.9	16.0	101.5
Totals	225.5	1419.0	202.4	1294.7	196.0	1343.6	177.4	1169.5

[1]In thousands

(SOURCE: Office of Migratory Bird Management, U.S. Fish and Wildlife Service)

Table II-87 also provides statistical information on duck stamp sales[1] and hunter (waterfowling) activity days for each of those four years. Both duck stamp sales and total hunter days have decreased over that time frame for the region as a whole, with only Maryland showing modest increases in both categories. It is difficult to determine trends and the factors involved in them for the individual states. In 1974 New York experienced a marked decline in total hunter days over 1973. This decline resulted from declines in the number of hunters as well as the average number of days hunted. New Jersey also experienced a decrease in the numbers of hunters but, because the average days hunted increased, total hunting days increased. The decline in duck stamp sales could be caused by many factors: weather conditions, the economic situation, self-imposed travel limitations due to gas shortages, and lack of success in previous years. It is impossible to determine the relative significance of these factors, but success in previous years is undoubtedly an important one. During this timeframe, the duck harvest has declined in most of the states, but goose harvest has increased at the same time. Consequently, it is not easy to determine which factors account for generally observed trends.

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[1]The purchase of a duck stamp is required by Federal law in order to participate in waterfowling.

Additionally, it is even more difficult to determine to what levels waterfowling activity might decline or recover.

The succeeding discussion will provide some water-related recreation informaton for each of the five Mid-Atlantic states. As previously noted, the data is generated and displayed differently in the SCORP's of the respective states. Consequently, the data displayed here is only applicable internally within a state.

New York

Table II-88 summarizes the number and percentage of New York's population that participated in the respective water-related recreational activities at least once during the year in 1970. The data is broken down for Metropolitan New York as well as for the state as a whole. More than half the populace participated in swimming during the year in Metropolitan New York and almost a fifth participated in fishing and boating. A larger percentage of people from the Metropolitan New York region swam, than did in other regions of the state. However, a smaller percentage of this region's population fished and boated than was true of other regions. This can possibly be explained by the readily accessible beaches of Long Island coupled with the relative inaccessibility, both physical and fiscal, to boating and fishing opportunities in the Metropolitan New York area.

TABLE II-88. WATER-RELATED RECREATION PARTICIPATION IN NEW YORK STATE--1970

ACTIVITY	STATEWIDE		METROPOLITAN NEW YORK[3]	
	PARTICIPANTS[1]	PERCENT PARTICIPATING[2]	PARTICIPANTS[1]	PERCENT PARTICIPATING[2]
SWIMMING	9255	50.7	6485	52.9
FISHING	3460	19.0	2287	18.6
BOATING	3280	18.0	2171	17.7
PICNICKING	8879	48.7	6138	50.0
CAMPING	1679	9.2	1033	8.4
HUNTING	1473	8.1	833	6.8

[1]Number of individuals that participate in an activity at some time during the course of the year, given in thousands of persons.

[2]Percentage of the area's population that participates in an activity at some time during the course of the year.

[3]Includes Long Island, New York City, and the Lower Hudson Valley.

(SOURCE: Forecast of Outdoor Recreation in New York State, 1970-1990, 1973)

The swimming activity (as well as others) generated by Metropolitan New York populations which takes place at the Long Island beaches occurs to a great extent at the state parks listed below and located on Figure II-70.

State Park	Size in Acres[1]	1974 Visitation[1] in thousands
Jones Beach	2,413	12,467
Gilgo	1,223	Included with Jones Beach
Captree	298	Included with Jones Beach
Robert Moses	1,000	2,523
Heckscher	1,657	911
Hither Hills	1,755	Included with Montauk Point
Montauk Point	724	657

Significant numbers of visitors also utilize locally and/or privately owned beach areas. Statistics on such use are not available, however. In spite of the fact that the percentage of the population participating in boating was smaller in the New York City region than in others, it is estimated that three-fifths of New York's boaters live in the New York Metropolitan region. In this area difficulty is often experienced by owners of trailered or car-top boats because of the

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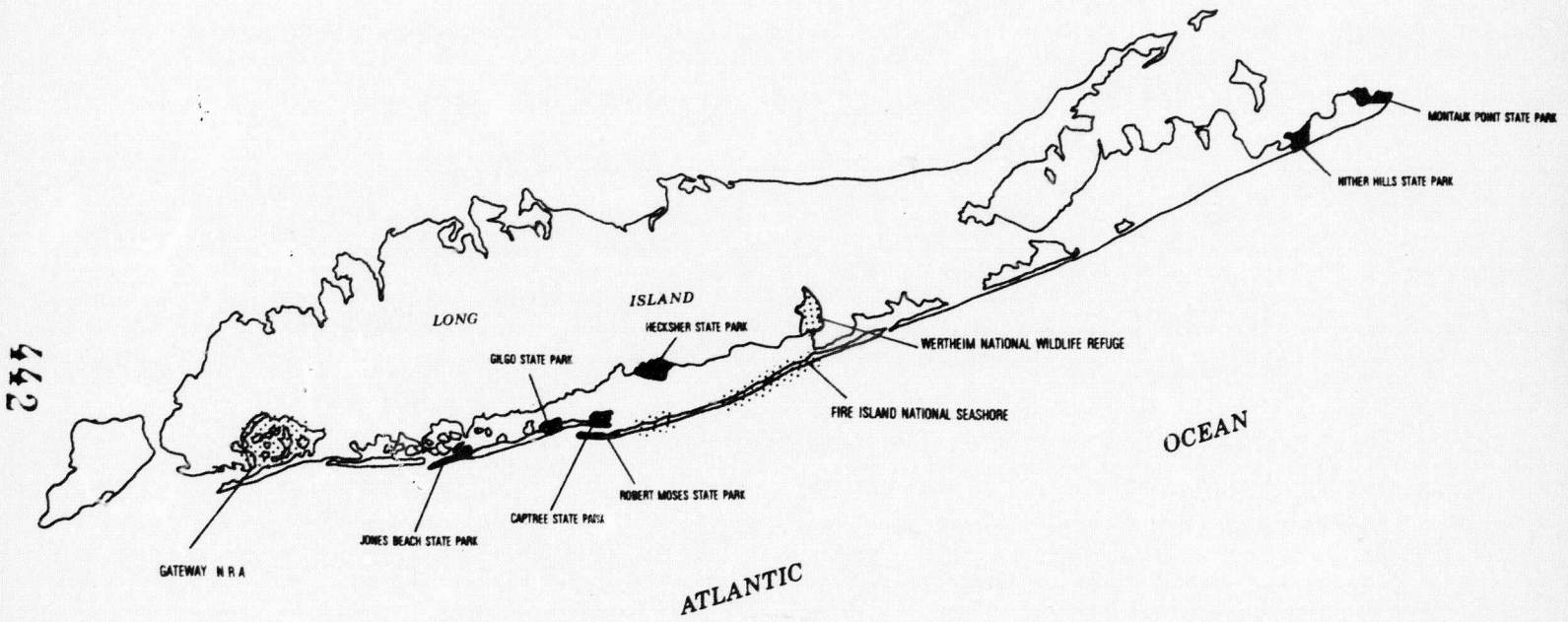
[1]Source: New York Office of Parks and Recreation.

FIGURE II-70. RECREATION RESOURCES



limited availability of boat storage space. Additionally, some portions of the shore are privately owned and/or utilized for commercial shipping operations which limits accessibility to the water. These factors combine to discourage participation which could otherwise be expected. Even given that situation, approximately one-third of New York State's total boating demand is focused on the Atlantic Coast, Great South Bay, and Long Island Sound. The average weekend day-use for fishing is 171,000 persons with more than one-third of them active along the ocean front areas of Long Island and New York City. While on a statewide basis interest in boating ranks seventh out of twelve activities, the availability of coastal resources makes boating third in popularity on Long Island (Nassau and Suffolk Counties). The polluted urban waters, along with lack of access and competing uses, limit the number of suitable fishing areas and consequently total fishing activity.

New Jersey

Table II-89 displays information on the water-related recreation demand in New Jersey in 1970 for both shore areas and the state as a whole. Total peak season demand for swimming statewide was almost 40 million recreation days. Fishing demand was only one-fourth as much as swimming, and boating was only one-fifth as much. On an average weekend day during peak season more than 50 percent of the swimming, fishing, and boating activity in the state takes place in the shore areas.

TABLE II-89. WATER-RELATED RECREATION DEMAND IN NEW JERSEY - 1970

ACTIVITY	AVERAGE WEEKEND DAY DEMAND IN PEAK SEASON[1]		TOTAL PEAK SEASON DEMAND[1]
	STATEWIDE	SHORE AREAS[2]	STATEWIDE
SWIMMING	775	390	38,731
FISHING	193	118	9,637
BOATING	159	80	7,964
PICNICKING	282	131	14,112
CAMPING	56	40	2,779
HUNTING	54	28	3,729
NATURE WALKING	113	55	5,636

[1] In thousands of recreation days where one recreation day equals two individuals.

[2] Includes Monmouth, Ocean, Atlantic, Cape May, Cumberland, Salem Counties, and the southeastern portion of Burlington County.

(SOURCE: Outdoor Recreation in New Jersey, 1973)

The average weekend day demand (peak season) for water-related activities that occur in the shore areas, as a percentage of this demand for water-related activities occurring in all areas of the state, are listed below.

Swimming	- 50.3%
Fishing	- 61.1
Boating	- 50.3
Picnicking	- 46.4
Camping	- 71.4
Hunting	- 51.8
Nature Walking	- 48.6

(Source: N.J. SCORP, 1973)

As indicated in the Shore Use and Ownership section (II.G.1.d), large stretches of the New Jersey Atlantic shore are municipally operated as public recreation areas. These beach areas receive very large amounts of use. Due to private ownership of these areas, visitation statistics are not available. Visitation statistics for 1974 are available, however, for the five state-operated areas displayed on Figure II- 71and listed below.

Island Beach State Park	- 565,396
Barnegat Light State Park	- 86,077
North Brigantine Natural Area	- 41,058
Corson's Inlet Natural Area	- 94,203
Cape May Wetlands Natural Area	- 39,308

(Source: N.J. Department of Environmental Protection)

STATE AND FEDERAL

RECREATION AND OPEN SPACE AREAS

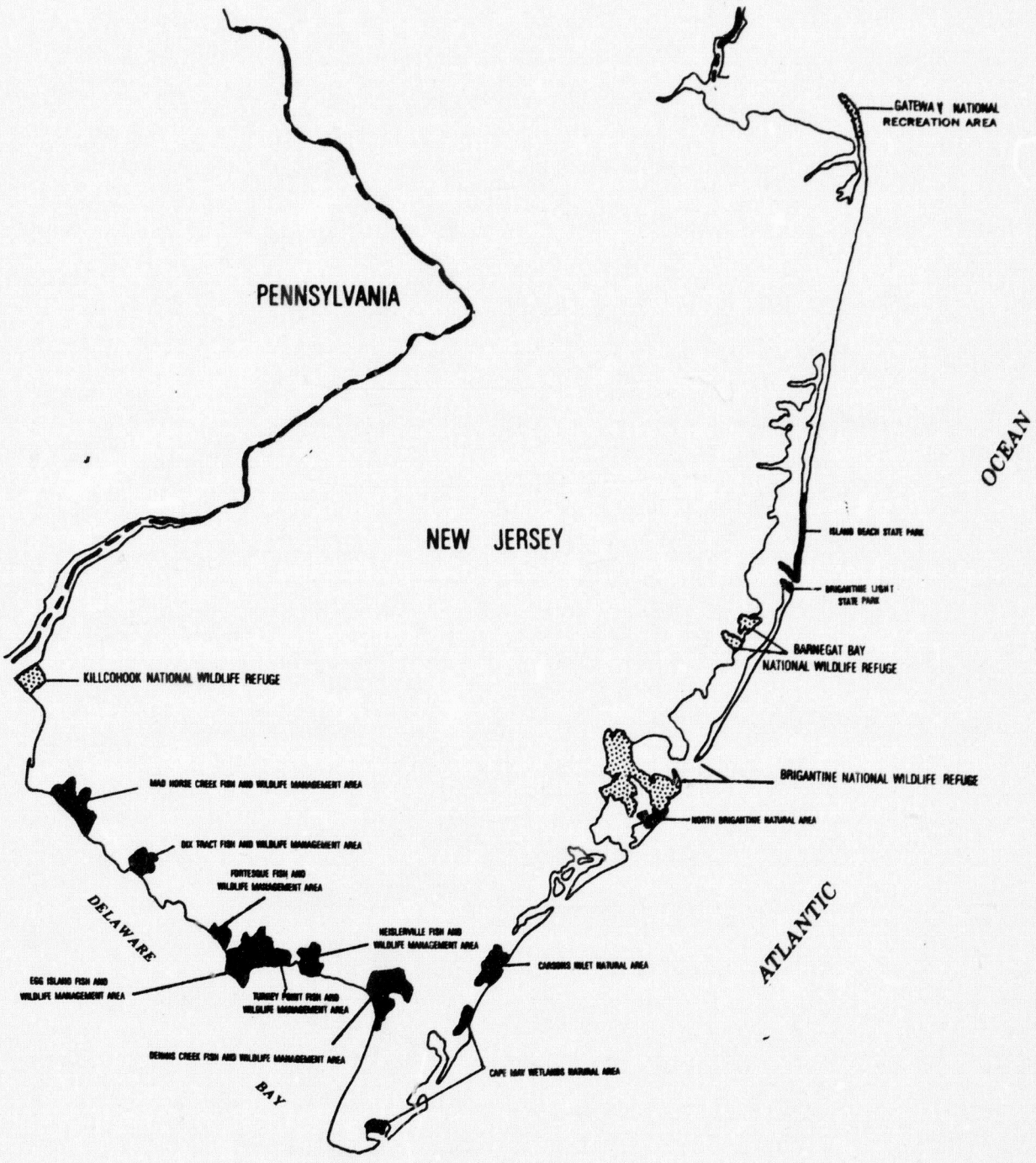


FIGURE II - 71.

The State also manages a series of wildlife management areas along the Delaware Bay shore. These areas sustain moderate levels of boating, fishing, and waterfowling use because they are managed primarily for fish and wildlife purposes with recreation being only an ancillary function. Statistical information on the actual levels of visitation at these areas is not available. State administered areas in New Jersey are displayed on Figure II-71.

Major portions of the recreation use which occur in the shore areas is generated by nonresidents of those areas. The shore areas of New Jersey serve as a recreation resource for the major urban populations of Pennsylvania, New York, and other areas in New Jersey. Listed below are the percentages of average weekend peak season demand in the shore areas that are generated by populations external to those areas.

Swimming	- 88.7%
Fishing	- 95.7
Boating	- 88.7
Picnicking	- 86.2
Camping	- N.A.[1]
Hunting	- N.A.
Nature Walking	- 87.2

(Source: N.J.SCORP, 1973)

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[1]Not available in the N.J. SCORP.

Such an influx of people from outside the shore areas has significant economic effects. These economic effects will be discussed in the Tourism subsection that follows.

Delaware

Almost all of Delaware's Atlantic coast shore is used for recreational purposes. Some of the shore is administered by the state as recreational areas. Other portions are administered for public recreational purposes by local municipalities as a means of attracting visitors. The Rehoboth and Bethany Beach areas function similarly to the Wildwood and Atlantic City areas in New Jersey, although not necessarily in the same magnitudes. The economic effects of this activity will be discussed in some detail in the Tourism subsection that follows.

Major portions of the Delaware Bay shore of the state are marshy and consequently unsuitable for beach-type use. There are several State and Federal wildlife management areas which provide some fishing, boating, waterfowling, and nature observation opportunities. Private bayshore marshes provide similar opportunities. Quantification of use of these areas is extremely difficult. Figure II-72 displays State and Federal shoreline recreation areas in Delaware. Table II-90 lists the state administered areas along with their acreages and the primary activities which they accommodate. The most current water-related recreation demand figures were generated as part of the 1970

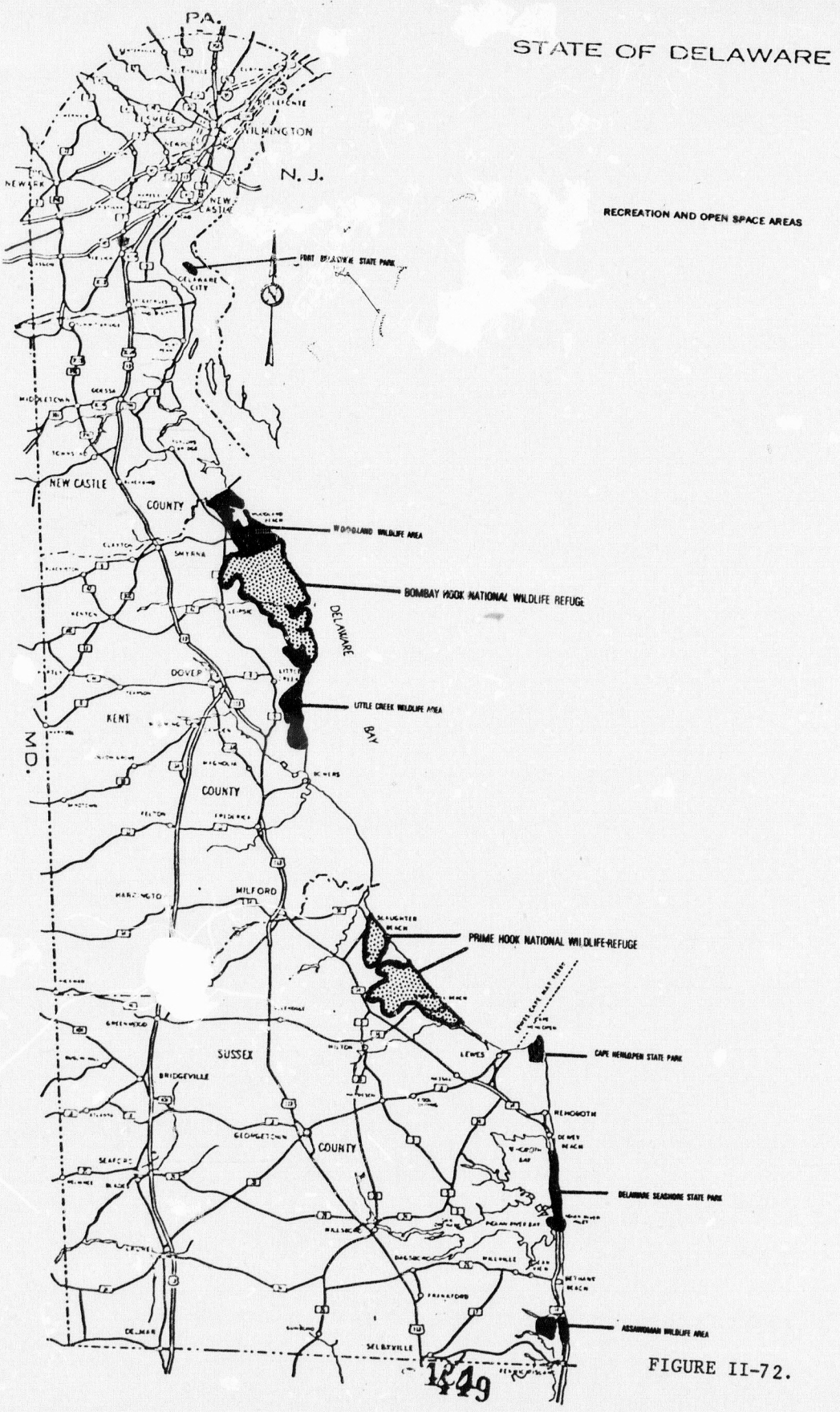
STATE OF DELAWARE
RECREATION AND OPEN SPACE AREAS
PA.
N. J.
MD.
WILMINGTON
NEWARK
NEW CASTLE
DELAWARE CITY
FORT DELAWARE STATE PARK
NEW CASTLE COUNTY
WOODLAND WILDLIFE AREA
SMYRNA
BOMBAY HOOK NATIONAL WILDLIFE REFUGE
DELAWARE BAY
DOVER
LITTLE CREEK WILDLIFE AREA
KENT COUNTY
MILFORD
SLAUGHTER BEACH
PRIME HOOK NATIONAL WILDLIFE REFUGE
SUSSEX COUNTY
LEWES
CAPE HENLOPEN STATE PARK
REHOBOTH
DEWEY BEACH
BRIDGEVILLE
GEORGETOWN
DELAWARE SEASHORE STATE PARK
SEAFORD
FRANKFORD
SELBYVILLE
ASSAWOMAN WILDLIFE AREA

FIGURE II-72.

TABLE II- 90.

MAJOR STATE OPERATED SHORELINE RECREATION AREAS IN DELAWARE

FACILITY	SIZE[1]	PRIMARY ACTIVITIES
Cape Henlopen State Park	1,641	Swimming, Fishing, Picnicking
Delaware Seashore State Park	1,759	Swimming, Fishing, Picnicking
Fort Delaware State Park	161	Fishing, Picnicking
Woodland Beach Wildlife Area	3,543	Hunting Waterfowl, Nature Study, Saltwater Fishing, Boating
Little Creek Wildlife Area	3,217	Hunting-Small Game and Waterfowl, Sightseeing
Assawoman Wildlife Area	1,460	Salt Water Fishing Boating

[1]Acres.

Delaware SCORP. The projections listed below are for 1980 and represent total state annual demand.[1]

Swimming	-	45,749
Fishing	-	1,747
Boating	-	4,075
Picnicking	-	3,484
Camping	-	626
Hunting	-	507

The total projected swimming demand is four times the combined projected demand for all of the other water-related recreation activities. When considering only ocean and bay swimming demands, which is anticipated to exceed 12 million user days in 1980, the total is still larger than the combined demand of the remaining activities.

Maryland

Almost all of the Atlantic Coast shore in Maryland is open to recreation use. Table II-91displays water-related recreation demand in Maryland for 1970. The table includes data on the annual and peak season demand for the activities on a statewide basis and for the Lower Eastern Shore. The beach swimming demand is most notable in that over one-third of the state's annual demand occurs on

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[1] In thousands of user days. Source: Delaware SCORP, 1970.

TABLE II-91.

WATER-RELATED RECREATION DEMAND IN MARYLAND - 1970[1]

ACTIVITY	STATEWIDE		LOWER EASTERN SHORE[2]	
	ANNUAL	PEAK SEASON	ANNUAL	PEAK SEASON
SWIMMING (Beach)	18,421	16,776	6,809	5,303
FISHING	15,253	8,236	2,422	1,308
BOATING	12,638	6,948	1,664	915
PICNICKING	40,748	13,019	4,047	1.293
CAMPING	6,128	3,112	994	478
HUNTING	7,815	4,128	1,327	684
NATURE WALKING	11,473	4,688	299	122

[1]In thousands of occasions.

[2]Includes Worcester, Dorchester, Wicomico, and Somerset Counties.

the Lower Eastern Shore. The area is rather sparsely populated and consequently, the overwhelming portion of the demand is generated by the influx of persons from other areas. The National Seashore and the State Park on Assateague draw many people to the region. The many commercial recreation facilities at Ocean City, while serving a different type of recreation demand, also draw many people into the region. The economic effects of this activity will be discussed in some detail in the Tourism section that follows.

Virginia

Most of Virginia's Atlantic Coast shoreline is marshy and relatively inaccessible for recreation use. The major exception is the Chincoteague National Wildlife Refuge which occupies the Virginia portion of Assateague Island. In addition, the U.S. Fish and Wildlife Service administers two smaller wildlife refuges, Fisherman's Island and Wallops Island.[1] The Commonwealth administers several areas along the southernmost portion of the coast as natural areas and/or wildlife management areas. Most of them are marshy and/or islands and consequently are inaccessible except by boat. These areas do receive some use, but statistics are not available to determine the extent.

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[1] Wallops Island National Wildlife Refuge is administered jointly with NASA under a cooperative management agreement.

Listed below are statistics on the 1972 annual water-related recreation demand for the entire state in thousands of activity days.

Swimming (beach use)	-	22,619
Fishing	-	24,500
Boating	-	11,331
Picnicking	-	16,713
Camping (family)	-	4,156
Waterfowling	-	438
Nature Walking and Hiking	-	44,712

(Source: Virginia SCORP, 1974)

There is a very large demand for the nature walking/observation type activity in the state, and it is projected to increase significantly over the next decades. The Eastern Shore may very well become a focal point for this activity, along with increases in the boating, fishing, and waterfowling activities which already exist.

Recreation and Access in the Chesapeake Bay Area

The Chesapeake Bay represents a major recreation resource for both Maryland and Virginia. The 7,325 miles of the Bay shoreline represent opportunities for a myriad of uses of the Bay. Unfortunately, one of its most obvious and socially desirable uses, recreation, is extremely limited at the present time. Chesapeake Bay is the most inaccessible estuary in the Nation. Ironically, a large percentage of the shoreline which is publicly accessible (is held by the Federal government) and yet is unavailable to the general public. A few of the recreational beaches have been closed due to water pollution

Water quality has deteriorated in some sections of the tributaries precluding the use of the water for active recreation. In urbanized areas (Baltimore) where opportunities are most sorely needed, the shoreline has often been used to provide transportation corridors without providing for public use of the shore.

Physiographically, much of the shore wetlands are not amenable to contemporary recreation-type development. Much of the shorelands that are recreationally developable and desirable are located along the tributaries and embayments which are desirable for many other purposes as well. Much of the desirable land type is sand beach and, where it occurs, it is the target of the residential development (seasonal and year round), utilities developers, industrial developers, and various public agency developments. Even biological factors impede the ready utilization of Chesapeake Bay for recreation. The stinging sea nettle is foremost among those nuisances, but growths of aquatic plants are also evidenced in areas otherwise suited to recreation development. In spite of evident problems, the vast Chesapeake Bay shoreline does possess a tremendous potential for providing public recreation benefits as well as supporting a substantial recreation industry. Figure II- 73 gives the general locations of Federal, State and local recreation and open space areas on the Bay.

An overview of recreation resources along the entire Atlantic Coast may be found in the Final EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol. 1, pp. 460-472.

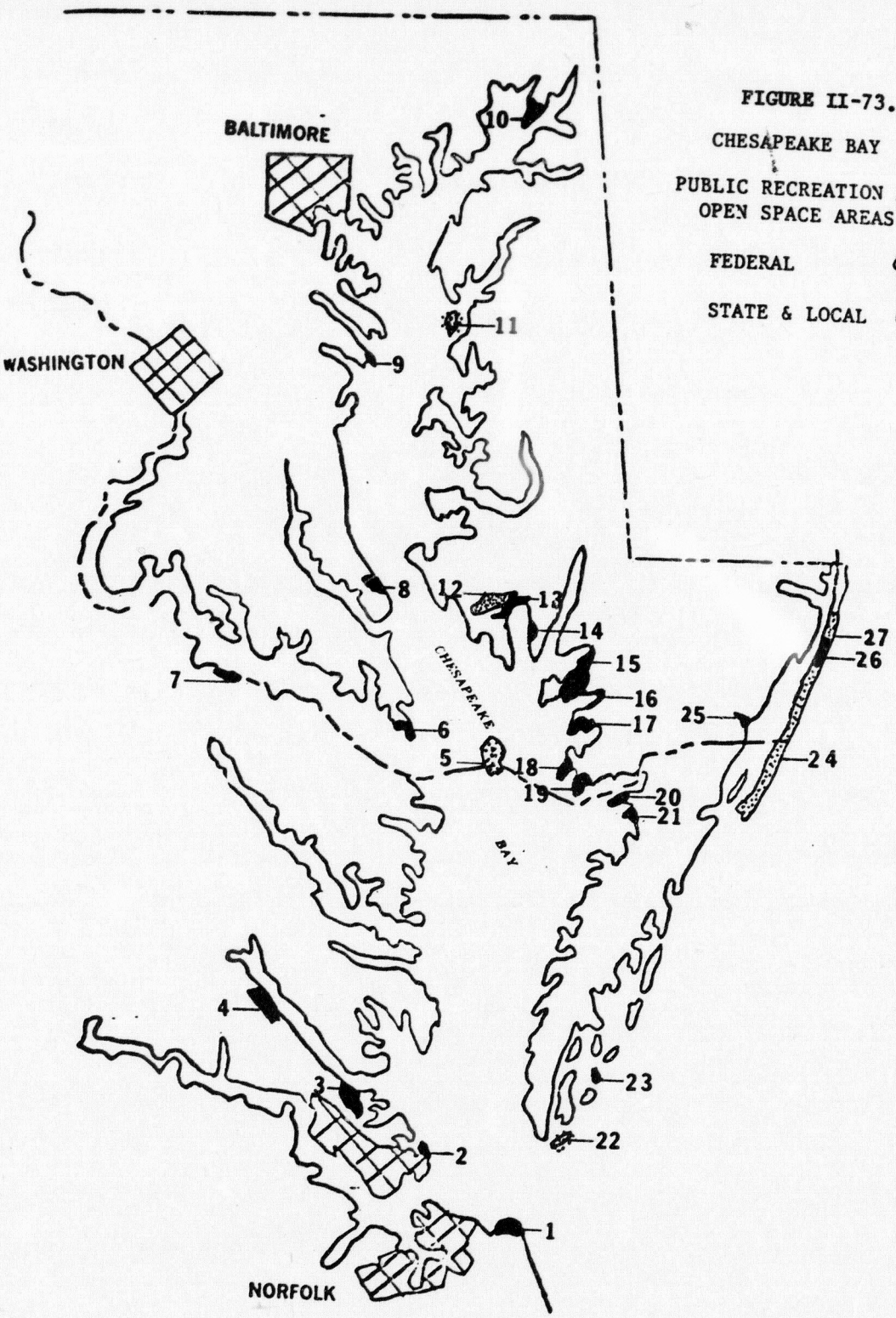

FIGURE II-73.

CHESAPEAKE BAY

PUBLIC RECREATION AND OPEN SPACE AREAS

FEDERAL

STATE & LOCAL

Legend for Figure II-73.

CHESAPEAKE BAY
Public Recreation and Open Space Areas

1--Seashore State Park
2--Grandview Park
2--Colonial National Historical Park
4--York State Park
5--Martin National Wildlife Refuge
6--Point Lookout State Park
7--Westmoreland State Park
8--Calvert Cliffs State Park
9--Sandy Point State Park
10--Elk Neck State Park
11--Eastern Neck Wildlife Refuge
12--Blackwater National Wildlife Refuge
13 & 14--Fishing Bay State Wildlife Area
15--Deal Island Wildlife Area
16--Manakin River Conservation and Recreation Area
17--Fairmont State Wildlife Area
18--Jane's Island Wildlife Area
19--Cedar Island State Wildlife Area
20 & 21--Saxis Wildlife Management Area
22--Fisherman's Island National Wildlife Area
23--Wreck and Bone Natural Area
24 & 27--Chincoteague National Wildlife Refuge
25--E.A. Vaughn State Wildlife Management Area
26--Assateague National Seashore

Tourism

The terms "recreation" and "tourism" most often refer to the same types of human activity, yet each has a different connotation; recreation is generally viewed as a sociological phenomenon whereas tourism is considered from an economic viewpoint. This section will discuss the economic significance of the recreational activity previously discussed.

The analysis focuses on the following Mid-Atlantic coastal counties:

Suffolk (New York)
Nassau (New York)
Monmouth (New Jersey)
Ocean (New Jersey)
Atlantic (New Jersey)
Cape May (New Jersey)
Cumberland (New Jersey)
Kent (Delaware)
Sussex (Delaware)
Worcester (Maryland)
Accomack (Virginia)
Northampton (Virginia)

The broad category of travel consists of several subcategories: business travel, convention-induced travel, travel for personal or family purposes, and pleasure travel. The latter subcategory, pleasure travel (hereinafter refered to as tourism), is discussed here exclusive of the other elements of travel because it is the most discretionary of all travel types. Consequently, tourism is more apt to be affected by activities and events that could be associated with OCS oil and gas development should the proposed action be taken.

Data on the economic significance of tourism, detailed to the county unit level, are virtually nonexistent[1]. Consequently, BLM entered into a contract with the United States Travel Data Center (Data Center)[2] to develop a methodology which could be used to generate such data. The data which is displayed and discussed on the succeeding pages was taken from an October 1975 report prepared by the Data Center pursuant to that contract.[3]

Travel expenditures occur before a trip is begun, enroute to and from a destination, and at the destination. Any event that affects the attractiveness of a destination area will impact on the destination travel expenditures (and subsequent economic activity) in that area.[4] Such events will probably have minimal impact on the anticipation and enroute expenditures of persons merely passing through an area or

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[1]Subsequent to publication of the Draft EIS a draft report, The Resort Economics of Cape May County, August, 1975, was submitted to BLM. It is discussed in some detail later in this section.

[2]The Data Center is an independent, nonprofit organization devoted to research on travel and tourism. Located in Washington, D.C., the center was organized in 1973 with the support of the Discover America Travel Organization and the Travel Service, U.S. Department of Commerce.

[3]This U.S. Travel Data Center report, Travel Economic Impact Model Final Demonstration Report, is available for review in the BLM New York OCS Office, Six World Trade Center, Suite 600D, New York, New York 10048. It can be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22151 (NTIS Accession Number PB249365/AS).

[4]The individual Mid-Atlantic coastal counties were treated as separate destination areas for data generation and analysis purposes.

of residents of an area who are travelling to destinations outside of their own residence areas. Consequently, these latter figures are excluded and the estimates presented in this section concentrate on the expenditures of travelers to the Mid-Atlantic coastal counties as destinations. All overnight trips and all day trips of more than 100 miles one way are included. Day trips of less than 100 miles one way were excluded from the Data Center report because of the unavailability of reliable data from which to generate economic estimates.

In summary, the method of generation of the statistical material on Mid-Atlantic coastal tourism discussed in the remainder of this section results in some obvious limitations on its applicability. The following factors should be kept in mind when reviewing this data:

Failure to include the economic impact of day use trips less than 100 miles one way.

Day use at the shore areas in the Mid-Atlantic states is very high, particularly on summer weekends. The large urban populations of metropolitan New York/New Jersey, Philadelphia, Baltimore and Washington are within the 100 mile day use travelling distance of much of the shore recreational resources. Although the economic significance of individual instances of day use may be small in relation to overnight and/or long term use, the cumulative economic impact of day use may well be very important because of the numerically large amount of day use which occurs in the Mid-Atlantic coastal areas. Unfortunately, reliable data on this aspect of tourism was not available for inclusion in the Travel Economic Impact Model.

The data generated only includes pleasure travel

The generation of travel data was limited to pleasure travel (tourism) because it was felt that this type of travel was the most susceptible to the possible impacts which could result from OCS oil and gas development. Business travel, travel for personal reasons and convention travel were excluded from the calculations. This necessarily results in lower estimates for all of the counties. Some counties' totals may be influenced more than others. It may be argued, for instance, that convention travel should have been included in the economic estimates generated because it is the natural resource base that provides the attraction for the convention travel. If convention travel had been included Atlantic County would have been the chief benificiary (in the way of increased estimates) among the twelve counties included in the analysis because of the convention facilities at Atlantic City.

Limitations on data input availability

This model was developed because of the unavailability of specific county level tourism data. In most instances, State level data was "modeled down" to the county level through the application of various factors and ratios. In some instances the data inputs were recognized as not being the most optimum but were used because of the lack of more meaningful data sources. The survey to obtain the data was conducted during March of the survey year. While this may have reasonable

Statewide validity it proves to be deficient when applied to the coastal counties because of the highly seasonal nature of tourism based employment.

The data generated by use of the model has limited applicability when viewed in absolute terms. It should be borne in mind, however, that an important purpose of the modeling exercise was to determine the relative importance of tourism as among the coastal counties surveyed. Since the biases of the model are internal they are applied equally to all the counties. Consequently, the conclusions as to the relative importance of tourism in the counties' economics appear valid.

Table II-92, II-93, and II-94 provide estimates of primary tourism business receipts, personal income, and employment, respectively for the twelve coastal counties enumerated above. The primary tourism activity referred to is focused in the following Standard Industry Categories II (SIC):[1]

Air transportation (45)
Taxicab companies (412)
Automobile dealers (55 exc 554)
Gasoline service stations (554)
Intercity highway passenger transportation (413)
Water transportation (44)
National Railroad Passenger Corporation

Hotels, motels and tourist courts (701)
Trailer parks and campsites (703)
Residential construction (152, 1531)

Motion picture, amusement and recreation services (78, 79)
General merchandise and miscellaneous retail stores (53, 59)
Eating and drinking places (58)

[1]U.S. Bureau of the Census Classifications.

TABLE II-92 .

TOURISM BUSINESS RECEIPTS BY TYPE OF LODGING FOR THE MID-ATLANTIC COASTAL COUNTIES IN 1972 (PRIMARY)[1]

Type Of Lodging	Suffolk (N.Y.)	Nassau (N.Y.)	Monmouth (N.J.)	Ocean (N.J.)	Atlantic (N.J.)	Cape May (N.J.)
Camper/Trailer	752	1,047	798	552	2,258	1,242
Commercial	6,727	9,463	18,858	13,024	52,217	29,116
Vacation Home[2]	1,690	2,358	1,364	942	3,856	2,121
Day Use	353	395	440	295	1,208	664
Total	9,522	13,263	21,460	14,813	59,539	33,143

Type of Lodging	Cumberland (N.J.)	Kent (Del.)	Sussex (Del.)	Worcester (MD.)	Accomack (Va.)	Northampton (Va.)
Camper/Trailer	44	369	748	1,546	143	66
Commercial	1,047	2,318	4,700	9,966	853	397
Vacation Home[2]	76	956	1,938	3,063	123	57
Day Use	24	26	52	252	54	25
Total	1,191	3,669	7,438	14,827	1,173	545

[1]In Thousands of 1972 Dollars.

[2]Construction Sector Excluded.

(Data Source: Travel Economic Impact Methodology, Final Demonstration Report, U.S. Travel Data Center, 1975)

TABLE II-93.

TOURISM PERSONAL INCOME BY TYPE OF LODGING FOR THE MID-ATLANTIC COASTAL COUNTIES IN 1972 (PRIMARY)[1]

Type Of Lodging	Suffolk (N.Y.)	Nassau (N.Y.)	Monmouth (N.J.)	Ocean (N.J.)	Atlantic (N.J.)	Cape May (N.J.)
Camper/Trailer	189	263	189	131	535	293
Commercial	1,874	2,599	4,941	3,429	13,906	7,618
Vacation Home[2]	416	582	325	226	922	505
Day Use	82	89	98	64	262	143
Total	2,561	3,533	5,553	3,850	15,625	8,559

Type of Lodging	Cumberland (N.J.)	Kent (Del.)	Sussex (Del.)	Worcester (MD.)	Accomack (Va.)	Northampton (Va.)
Camper/Trailer	11	88	181	412	30	14
Commercial	280	600	1,238	2,743	202	95
Vacation Home[2]	19	227	468	803	26	12
Day Use	5	5	11	58	10	5
Total	315	920	1,898	4,016	268	126

[1]In Thousands of 1972 Dollars.

[2]Construction Sector Excluded.

(Data Source: Travel Economic Impact Methodology, Final Demonstration Report, U.S. travel Data Center, 1975)

TABLE II-94.

TOURISM EMPLOYMENT BY TYPE OF LODGING FOR THE

MID-ATLANTIC COASTAL COUNTIES IN 1972 (PRIMARY)

Type Of Lodging	Suffolk (N.Y.) Persons	Nassau (N.Y.) Persons	Monmouth (N.J.) Persons	Ocean (N.J.) Persons	Atlantic (N.J.) Persons	Cape May (N.J.) Persons
Camper/Trailer	37	51	41	30	121	66
Commercial	387	554	1,203	829	3,372	1,854
Vacation Home[1]	83	116	78	55	221	121
Day Use	16	19	25	15	63	34
Total	523	740	1,347	929	3,777	2,075

Type Of Lodging	Cumberland (N.J.) Persons	Kent (Del.) Persons	Sussex (Del.) Persons	Worcester (MD.) Persons	Accomack (Va.) Persons	Northampton (Va.) Persons
Camper/Trailer	2	25	51	113	9	4
Commercial	67	176	359	730	63	30
Vacation Home[1]	5	65	132	204	8	3
Day Use	1	2	3	15	3	1
Total	75	268	545	1,062	83	38

[1]Construction Sector Excluded.

(Data Source: Travel Economic Impact Methodology, Final Demonstration Report, U.S. Travel Data Center, 1975).

The economic estimates, as displayed in the tables, are broken down into four categories for each county by type of lodging: camper/trailer lodging, commercial lodging, vacation home lodging, and day use (no lodging). While tourist activity is drawn into a destination by presumably the same resources (that is, the ocean and the beaches), the magnitude of tourist activity is broken out here by lodging type to facilitate later discussion in Section III of possible impacts arising from OCS oil and gas-associated activities in the event this proposed sale is held.

Total 1972 business receipts were highest in the four New Jersey Atlantic coastal counties and Worcester County, Maryland (Table II-79). The hishest totals were in Atlantic and Cape May Counties with $59 million and $33 million in receipts, respectively. Worcester County, Maryland, where Ocean City is located, had the highest total for any of the counties outside New Jersey with almost $15 million in receipts. Although the specific percentages differed from State to State, in all of the counties except Kent and Sussex Counties, Delaware, more than two-thirds of the total receipts were attributable to commercial lodging-based tourism. In those two counties approximately 62 percent of the tourism-generated business receipts could be so attributed. Vacation home lodging tourist activity was the second most important segment in all of the counties except Accomack and Northampton Counties, Virginia. In total dollars, it was most significant in Atlantic County, New Jersey, but, as a percentage of a county's total tourism-generated business receipts, it was most significant in Worcester County, Maryland. Both camper/trailer and day-use tourist activities were relatively minor when compared with total tourism-generated business receipts in all of the counties.

Table II-95 displays estimates of primary tourism-generated personal income for the twelve counties. Only Atlantic, Cape May, and Monmouth counties had personal income estimates of more than $5 million in 1972. The patterns of significance[1] for primary tourism-generated personal income were similar to those for business receipts.

Table II-96 presents information on primary tourism-generated employment for the twelve counties. Four counties--Atlantic, Cape May, Monmouth, and Worcester--had primary tourism-generated employment totals in excess of one thousand persons. The patterns of significance within each of the counties were similar to the patterns recognized in the discussions of business receipts and personal income.

In order to get a broader picture of the economic significance of tourism in these counties, earning and employment multipliers were developed (Table II- 97) to estimate the secondary economic activity associated with (or dependent upon) primary tourism activity. Tables II- 95and II-96 display estimates of the total primary and secondary tourism-generated personal income and employment. The figures in the columns labeled "primary" are county totals taken from Tables II-93 and II-94 which were previously discussed. The figures in the columns labeled "secondary" were calculated by multiplying "primary" figures by the county earnings and employment multipliers that appear in Table II-97 .

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[1]Commercial based lodging tourism was the most significant, followed by vacation home based tourism. Camper/trailer and day-use tourism was relatively minimal.

TABLE II- 95.

TOTAL TOURISM-GENERATED PERSONAL INCOME FOR THE MID-ATLANTIC COASTAL COUNTIES IN 1972[1]

County	Primary	Secondary[2]	Total
Suffolk (N.Y.)	2,561	4,654	7,215
Nassau (N.Y.)	3,533	6,621	10,154
Monmouth (N.J.)	5,553	8,128	13,681
Ocean (N.J.)	3,850	6,464	10,314
Atlantic (N.J.)	15,625	25,701	41,326
Cape May (N.J.)	8,559	13,080	21,639
Cumberland (N.J.)	315	357	672
Kent (Del.)	920	767	1,687
Sussex (Del.)	1,898	1,914	3,812
Worcester (MD.)	4,016	4,085	8,101
Accomack (Va.)	268	214	482
Northampton (Va.)	126	111	237

[1] In Thousands of 1972 Dollars.

[2] Includes Construction Sectors.

Data Source: Travel Economic Impact Methodology, Final Demonstration Report, U.S. Travel Data Center, 1975.

TABLE II-96.

TOTAL TOURISM-GENERATED EMPLOYMENT

FOR THE MID-ATLANTIC COASTAL COUNTIES IN 1972

County	Primary	Secondary[1]	Total
Suffolk (N.Y.)	523	802	1,325
Nassau (N.Y.)	740	1,245	1,985
Monmouth (N.J.)	1,347	1,761	3,108
Ocean (N.J.)	929	1,182	2,111
Atlantic (N.J.)	3,777	4,942	8,719
Cape May (N.J.)	2,075	2,415	4,490
Cumberland (N.J.)	75	67	142
Kent (Del.)	268	173	441
Sussex (Del.)	545	415	960
Worcester (MD.)	1,062	836	1,898
Accomack (Va.)	83	49	132
Northampton (Va.)	38	24	62

[1] Includes Construction Sectors.

[2] Data Source: Travel Economic Impact Methodology, Final Demonstration Report, U.S. Travel Data Center, 1975

TABLE II-97. EARNINGS AND EMPLOYMENT MULTIPLIERS, BY COUNTY FOR 1967 AND 1972

County, State	Earnings Multipliers		Employment Multiplier	
	1967	1972	1967	1972
Nassau, N.Y.	2.40	2.69	2.44	2.59
Suffolk, N.Y.	2.36	2.64	2.29	2.45
Monmouth, N.J.	2.07	2.38	2.00	2.27
Atlantic, N.J.	2.35	2.55	2.13	2.27
Ocean, N.J.	2.23	2.57	1.98	2.23
Cumberland, N.J.	1.86	2.07	1.72	1.87
Kent, Del.	1.56	1.72	1.45	1.59
Sussex, Del.	1.75	1.87	1.63	1.70
Cape May. N.J.	2.19	2.44	1.98	2.13
Worcester, Md.	1.87	1.97	1.73	1.77
Accomack, Va.	1.90	1.78	1.63	1.58
Northampton, Va.	1.64	1.86	1.43	1.62

Source: Travel Economic Impact Methodology, Final Demonstration Report, U.S. Travel Data Center, 1975.

The preceding material provided quantitative data on the economic effects of tourism activity. Table II-98 compares tourism-generated employment estimates with the estimates of total countywide employment in 1972 for each of the twelve counties. Although only one indicator, this comparison sheds some light on the relative importance of tourism to the coastal counties' economy as a whole. In eight of the counties the tourism-generated employment accounted for less than 5 percent of total employment. In only three counties--Atlantic, Cape May, and Worcester--was the percentage greater than 10 percent. Atlantic County had the greatest number of tourism-generated employment with almost 9,000 employees. On a percentage basis, however, tourism activity was most significant in Cape May County where over two-fifths of the employment was tourism generated.

Another aspect of tourism activity is the tax revenues that accrue to state and local units of government. Table II-99 summarizes the estimates of corporate and individual income taxes, sales/gross receipts taxes, and property taxes. The largest revenues occurred in Atlantic and Cape May counties. The sales/gross receipts tax generated the largest revenues for the states, and the property tax generated the largest revenues at the local level.

TABLE II- 98.

TOURISM GENERATED EMPLOYMENT COMPARED WITH TOTAL EMPLOYMENT

IN TWELVE MID-ATLANTIC COUNTIES IN 1972

County	Total County Employment	Tourism[1] Generated Employment	Percent[2]
Suffolk	184,271	1,325	**
Nassau	387,076	1,985	**
Monmouth	90,939	3,108	3
Ocean	35,117	2,111	6
Atlantic	46,781	8,719	19
Cape May	10,412	4,490	43
Cumberland	40,451	142	**
Kent	20,755	441	2
Sussex	23,570	960	4
Worcester	8,219	1,898	23
Accomack	5,106	132	3
Northampton	2,371	62	3

[1]Includes Primary and Secondary Employment.
[2]Percentage Of Total County Employment Attributable To Tourism, Rounded To The Nearest Whole Percent.
** Less Than One Percent

(Data Sources: U.S. Travel Data Center, 1975; Bureau of The Census, 1972 County Business Patterns)

TABLE II- 99.

MAJOR STATE AND LOCAL TAX REVENUES GENERATED BY TOURISM EXPENDITURES IN THE MID-ATLANTIC COASTAL COUNTIES IN 1972[1]

	State			Local	
County	Corporate Income	Individual Income	Sales/Gross Receipts	Sales/Gross Receipts	Property
Suffolk (N.Y.)	31	74	457	343	193
Nassau (N. Y.)	42	102	575	431	266
Monmouth (N.J.)	42	N.A.	1,191	N.A.	342
Ocean (N.J.)	29	N.A.	819	N.A.	280
Atlantic (N.J.)	117	N.A.	3,182	N.A.	1,061
Cape May (N.J.)	65	N.A.	1,831	N.A.	718
Cumberland (N.J.)	2	N.A.	69	N.A.	20
Kent (Del.)	10	32	32	N.A.	16
Sussex (Del.)	19	66	65	N.A.	33
Worcester (Md.)	34	97	674	N.A.	240
Accomack (Va.)	2	5	49	16	5
Northampton (Va.)	1	2	22	7	2

[1]In Thousands of 1972 Dollars.

Data Source: U.S. Travel Center. 1975. Travel Economic Impact Methodology, Final Demonstration Report.

Additional Tourism Data

Data relative to tourism in the New Jersey shore counties, particularly Cape May County, has been provided in a report titled The Resort Economy of Cape May County, New Jersey. The purpose of the report was to examine the relationship between the economy of the county and land use, and as such is broader in scope than the U.S. Travel Data Service report. The Cape May County report does not include background material on the assumptions made and the data sources, so its applicability to all Mid-Atlantic coastal counties and its limitations are more difficult to judge than those of the Data Center model previously discussed.

Table II-100 shows assessed land value as an indication of investment in the resort economy of Cape May County. It assumes that 60 percent of the land value of the county is directly attributable to tourism, and another 30 percent indirectly attributable.

Table II- 101 shows estimated tourism retail sales for Cape May County. Estimates of tourism retail sales have been obtained from a publication entitled "Sales Management Magazine".

Table II-102 indicates jobs by class in 1974 for Cape May County. "Seasonal" jobs include all wholesale, retail and non-domestic services jobs (e.g., grocery stores, department stores, gasoline stations).

Table II-100.

ASSESSED VALUATION AS A MEASURE OF INVESTMENT IN RESORT INDUSTRY (IN $1,000,000's)

FOR CAPE MAY COUNTY

	1963	% County Total	1970	% County Total	1970-Adjusted* For Inflation	1973	% County Total	1973-Adjusted* For Inflation
Direct Investment [1] In Resort Economy	$340	60%	$551	64%	$429	$802	61% [2]	$543
Direct and Indirect [3] Investment in Resort Economy (90% of County Value)	$507	90%	$770	90%	$600	$1,179	90%	$798
Total Assessed Valuation	$564		$856		$667	$1,309		$887

* These represent 1970 and 1973 figures that have been adjusted to their equivalent 1963 dollar value by using the Consumer Price Index to reduce these figures to 1963 dollar buying power value.

1. A direct investment is a property which exists solely for, or because of, the tourist industry such as a hotel or motel, a summer home, a seasonal retail store or a campground.

2. The direct investment in the resort economy shows a drop from 1970 to 1973 of 3% (down from 64% to 61%). This was a result of the methodology used to calculate what portion of commercial ratables are due to direct investment in the resort economy. The methodology is based on the Cape May County Planning Board estimate of the 1973 summer and winter population. The Board's projections for the years 1970 through 2010, assume that the permanent winter population is, and will be, growing at a faster rate than the summer transient population. This results in a larger portion of commercial ratables being attributed to the permanent (non-resort) population each year.

3. An indirect investment is a property which exists partially for or because of the tourist industry such as a year round retail outlet, private home of a person employed in tourist industry or commercial fishery.

Data Sources: 1970 Bureau of the Census, Cape May County Board of Taxation (Abstract of Ratables)

From: Cape May County Planning Board

Table II-101.

TOURISM RECEIPTS FOR CAPE MAY COUNTY

TOURIST RETAIL SALES

	1950	% Total	1960	% Total	1970	% Total	1973	% Total
Tourist Retail Sales	$18,846,481	35	$43,727,940	48	$90,376,328	53	$122,153,323	46
Total Retail Sales	$54,391,000		$92,117,000		$170,973,000		$265,724,000	
In 1963 Dollars	$24,264,844		$43,006,235		$71,692,450		$ 78,213,938	

RENTAL INCOMES FROM TOURISTS[1]

Dwelling Units	Motels and Hotels	Campgrounds	Total
$54,446,400 [2]	$61,959,600 [3]	$3,162,900 [4]	$119,568,900

TOTAL OF RETAIL SALES AND RENTALS: $241,722,223

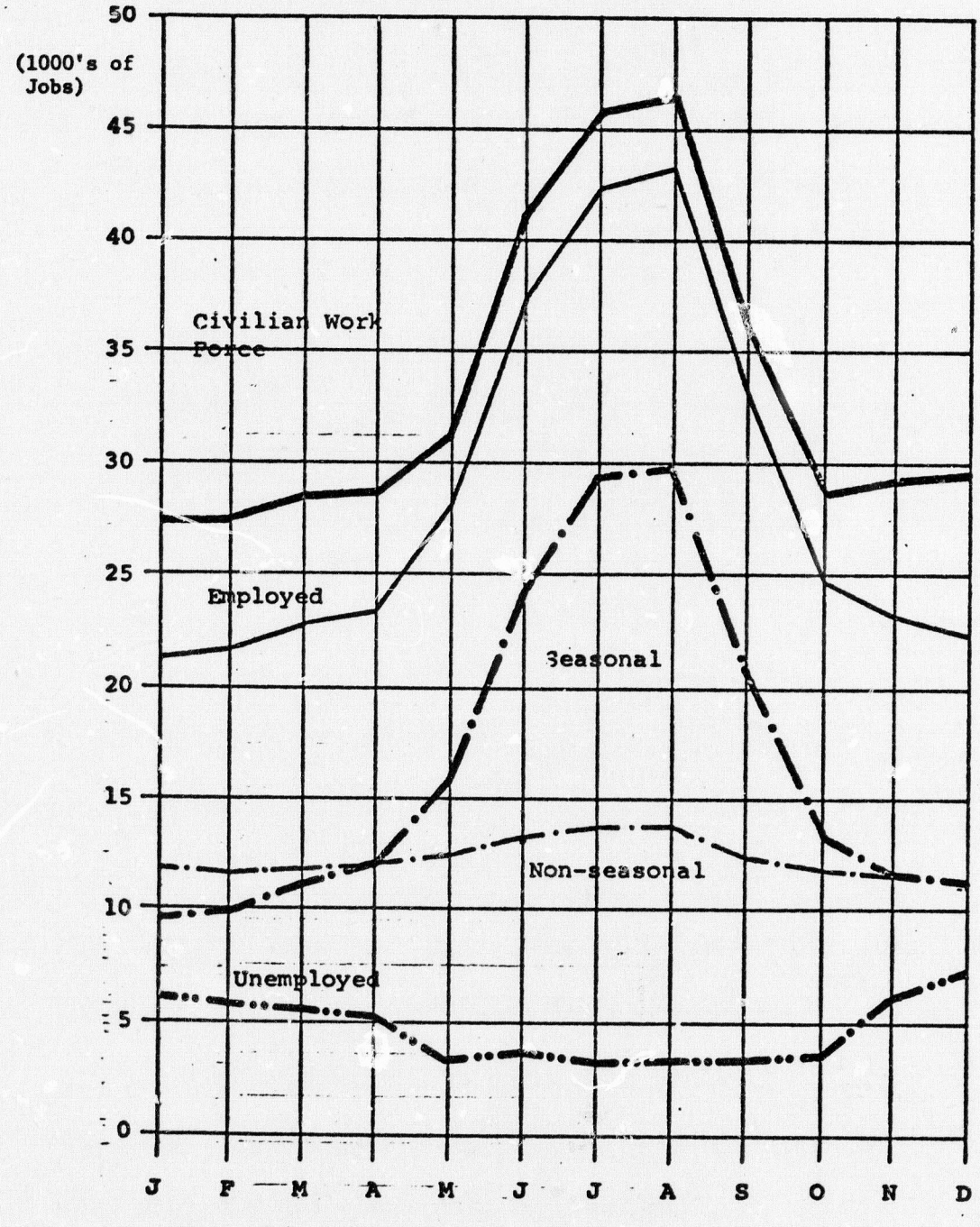
1. Counts of Dwelling Units, Motel & Hotel Rooms & Campsites were obtained from municipal tax records
2. 36,297 seasonal Dwelling Units at $1,500/season = $54,446,400
3. 22,944 Motel & Hotel rooms at $2,700/season= $61,959,600
4. 10,543 Campsites at $300/season = $3,162,900

Data Sources For Retail Sales: New Jersey Department of Labor & Industry

From: Cape May County Planning Board

Table II-102.

Resident Jobs by Class in Cape May County, 1974



Data Source: New Jersey Department of Labor & Industry

From: Cape May County Planning Board

The Cape May County report compares some aspects of Cape May County's economy and tourism factors with those for Atlantic, Monmouth and Ocean Counties. Table II-103 shows the rate of change in seasonal and non-seasonal dwelling units for the four counties.

Another comparison is the portion of retail sales dollars to buying power dollars attributable to tourism - a measure of the dollar importing power of the counties. Using the statewide average of $.51 of retail sales per dollar of buying power as a measure of that assumed to be from residents, $.44 in retail sales for every dollar of buying power is calculated for Cape May County, while $.27, $.25, and $.11 are calculated for Atlantic, Ocean, and Monmouth Counties, respectively.

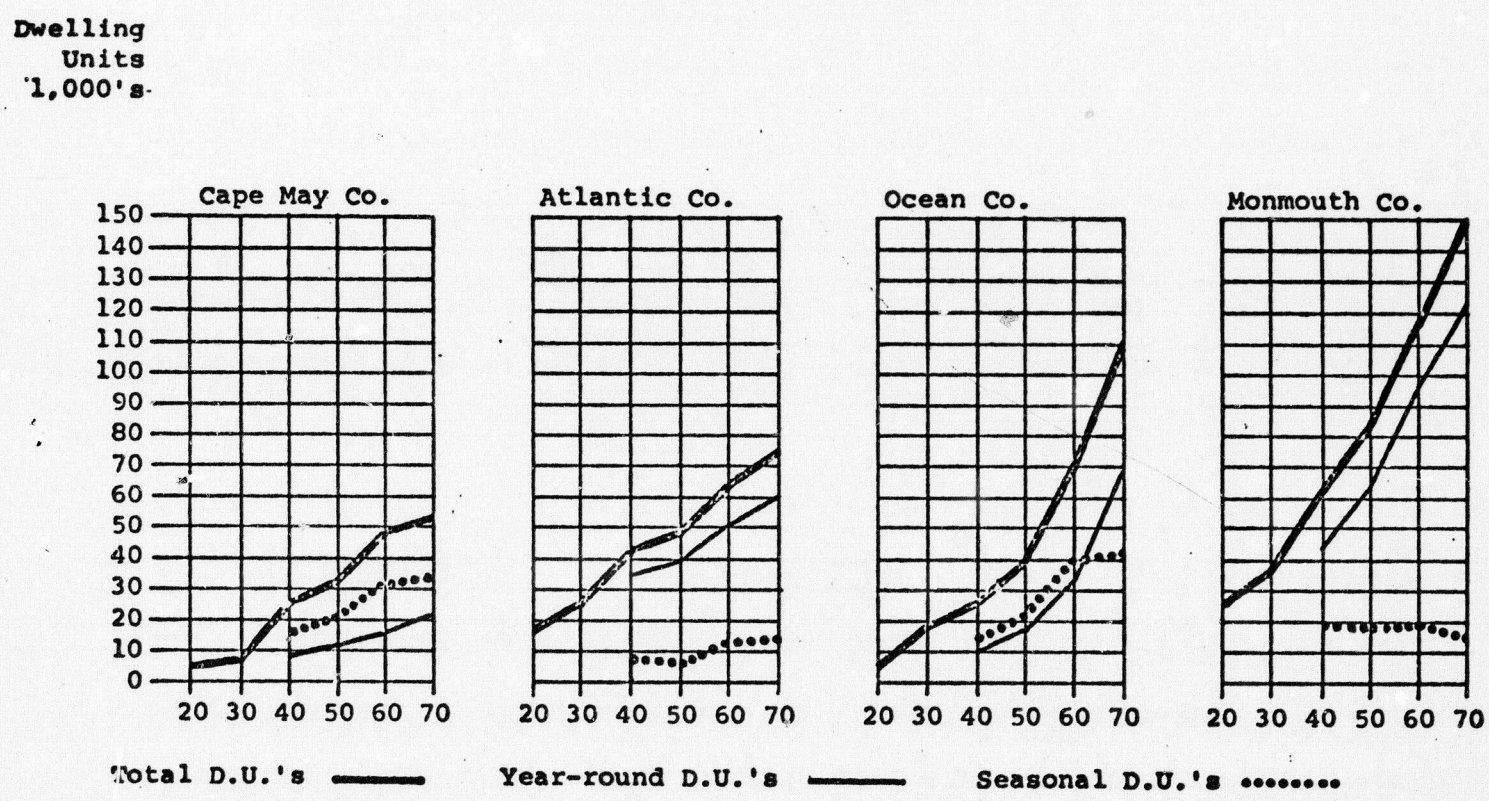
As previously stated, all of the assumptions underlying these data are not presented in the referenced report. Data from the New Jersey Department of Labor and Industry is utilized for many factors whereas the U.S. Travel Data Center utilized U.S. Census data. In addition, the Cape May County report was much broader in scope than the U.S. Travel Data Center model, which attempted to measure that aspect of travel felt to be most sensitive to economic consequences as a result of an oil spill occurrence.

However, both reports lead to the same conclusion; that is, that in the Mid-Atlantic ocean shore counties, particularly in southern New Jersey, and also in Maryland (U.S. Travel Data Center report), tourism represents a very substantial part of the total economy, and that this economic factor is subject to great seasonal fluctuations.

Table II-103.

CAPE MAY COUNTY

Dwelling Unit Status for the Four Seashore Counties
(1940 - 1970, seasonal vs. year-round)*



* Breakdown of seasonal/year-round dwelling units for 1920 and 1930 are not available

Source: U.S. Bureau of the Census

From: Cape May County Planning Board

f. Commercial and Sports Fisheries

Commercial Fisheries

Saila and Pratt (1973) report that approximately 300 species of marine fishes are known to occur in the Mid-Atlantic Bight. Of this total, less than one-half consistently occur from year to year. They also report that "about 30 species" are of significant commercial value at the present time even though approximately 80 species are listed as commercial species.[1]

Foreign commercial fisheries in the area from Long Island south to the Chesapeake Bay account for over 200,000 metric tons or about 25 percent of the catch in the area (International Commission on North Atlantic Fisheries, 1974). A breakdown of these statistics is given in Table II-104.

Table II-104.

Foreign Commercial Catches for 1974 from the Mid-Atlantic Region

Country	Metric Tons Landed
Poland	63,052
U.S.S.R.	52,206
East Germany	51,517
Bulgaria	21,639
Other	23,252

Source: International Commission on North Atlantic Fisheries, 1974.

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[1]Visual 4 depicts the generalized distributions of commercial fish and shellfish species.

The major fish species of importance in the foreign catch are red hake, mackerel, squid, herring, butterfish, saury and tuna. These may be compared to fish species of domestic interest by referring to Table II-105 in this section.

At the present time the foreign fishery is not restricted as to types of gear which can be used or the extent of catch. This makes it difficult to obtain accurate statistics on the extent of the foreign fishery. Indeed, many people consider the figures of ICNAF to be conservative estimates of actual catch by foreign fishermen. Control over foreign fishing enterprises, with the intent to manage the resources to obtain a sustained optimum yield, will be forthcoming as a result of the recently enacted Marine Fisheries Conservation Act of 1976 (P.L. 94-264).

No definitive statement can presently be made concerning the effect of this new law on the fisheries resource, although better management could result in a more sustained yield. The effect cannot be quantified at this time, however. Neither can any statement be made as to the effect of the law on the ability of the domestic fishing industry to exploit or market a larger percentage of the fisheries resource. However, the magnitude of foreign catch, in combination with domestic catch statistics, does help to indicate the extent of the fisheries resource in the Mid-Atlantic area.

Table II-105. Species Rank by Pounds Landed and Dollar Values for 1970-73 for Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia. (National Marine Fisheries Service, Fish Statistics, 1970-1973)

Pounds Landed				Species (by decreased pounds)	Dollar Value			
1970	1971	1972	1973		1970	1971	1972	1973
1	1	1	1	Menhaden	1	4	3	3
2	2	2	3	Blue Crab	6	5	5	5
3	3	3	2	Surf Clam	5	6	6	4
4	8	5	4	Oyster	2	3	1	1
7	4	4	5	Yellow-tail Flounder	12	8	7	7
6	5	6	6	Quahog (hard)	3	1	2	2
5	6	7	8	Alewife	20	22	22	22
11	10	8	9	Whiting	14	15	14	12
8	11	9	11	Scup or Porgy	9	9	11	11
10	7	13	15	Winter Flounder	13	13	15	14
9	9	12	16	Lobster	4	2	4	6
12	14	11	10	Striped Bass	11	12	10	8
17	12	10	12	Weakfish	18	14	13	13
15	16	15	14	Summer Flounder	10	11	9	9
21	15	14	13	Herring	25	24	25	25
13	13	21	25	Soft Clams	7	7	12	17
18	18	17	7	Bluefish	22	18	18	18
16	20	16	18	Shad	19	19	16	19
20	17	25	17	Butterfish	15	16	20	15
19	19	20	19	Cod, Atlantic	21	17	17	20
14	25	18	21	Spot	16	25	21	21
22	21	19	20	Mackerel	24	23	24	24
23	22	22	24	White Perch	23	20	23	23
24	24	23	22	Black Sea Bass	17	21	19	16
25	23	23	23	Scallops	8	10	8	10

Because of the lack of accurate data on species caught by foreign fishermen, this section concentrates on the U.S. commercial fisheries economy. Annual domestic catch, both volume and value of fish landed for 1970-1973, is given in Table II-106 for the States of Rhode Island, Connecticut, New York, New Jersey, Delaware and Maryland and Virginia on a State-by-State basis.[1]

Rankings by volume and value of domestic catch were compiled for the more significant species in the Mid-Atlantic Bight area. They account for the great majority of the total catch for the areas as indicated in Table II-107. Discussion on species is therefore limited to a selected few. According to Saila and Pratt (1973), some species show less stability than others which is perhaps due to relative abundance. Population trends based on harvest statistics are given in a following section.

Total harvest of finfish species exceeds that of shellfish species in terms of pounds landed (Table II-106). However, shellfish species have a higher economic value. Their value nearly doubles that of finfish species.

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[1]Rhode Island and Connecticut data are included since some fish landed by those States were caught in the Mid-Atlantic region. Chesapeake Bay data are also included.

Table II-106. Total Fish Landings by States
(Pounds and dollar value x 10^3)
(From National Marine Fisheries Service, 1970, 1971, 1972, 1973)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970								
Finfish	70,690	3,213	16,608	51,196	300	15,894	506,243	664,144
	$ 4,405	$ 394	$ 2,407	$ 3,610	$ 59	$ 1,826	$ 13,237	$ 25,938
Shellfish	8,704	1,590	15,876	46,351	9,660	64,003	107,795	253,979
	$ 6,462	$ 1,259	$ 13,710	$ 8,895	$ 1,234	$ 16,740	$ 24,872	$ 73,172
1971								
Finfish	77,024	5,029	20,177	80,528	432	16,181	427,155	626,526
	$ 5,150	$ 498	$ 2,577	$ 4,050	$ 92	$ 1,719	$ 9,296	$ 23,382
Shellfish	9,070	1,751	16,183	35,058	9,186	58,933	64,609	194,790
	$ 7,402	$ 1,254	$ 8,923	$ 8,149	$ 1,559	$ 17,948	$ 12,575	$ 64,880
1972								
Finfish	75,228	3,209	21,821	161,540	810	16,248	584,412	863,068
	$ 6,835	$ 288	$ 3,181	$ 5,867	$ 141	$ 1,722	$ 13,048	$ 31,082
Shellfish	7,036	1,230	15,188	28,976	11,738	53,731	81,769	199,668
	$ 5,757	$ 1,213	$ 18,837	$ 8,555	$ 2,331	$ 17,504	$ 13,775	$ 67,972
1973								
Finfish	89,506	5,404	21,501	179,478	1,152	20,543	541,587	859,171
	$ 8,812	$ 618	$ 4,690	$ 8,808	$ 291	$ 2,506	$ 25,329	$ 51,054
Shellfish	7,113	1,209	14,545	30,318	9,509	49,874	89,157	201,725
	$ 5,906	$ 1,520	$ 12,135	$ 9,637	$ 1,895	$ 18,989	$ 15,528	$ 65,610

Table II-107.

Major 25 Species Given as a Percentage of Total Catch (Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia)
(National Marine Fisheries Service, Fishery Statistics)
1970, 1971, 1972, 1973

	Pounds ($\times 10^3$)	Dollar Value ($\times 10^3$)
1970	$\frac{804,906}{918,123} = 89.1\%$	$\frac{94,240}{99,110} = 95.1\%$
1971	$\frac{781,438}{821,316} = 95.1\%$	$\frac{75,419}{79,339} = 95.0\%$
1972	$\frac{1,026,735}{1,062,736} = 96.6\%$	$\frac{97,371}{99,052} = 98.3\%$
1973	$\frac{1,003,720}{1,060,896} = 94.0\%$	$\frac{141,423}{146,993} = 96.2\%$

Shapiro (1971) reports that 27,000 men and 18,000 vessels are engaged in commercial fishing in the Mid-Atlantic Bight area. Data compiled from the National Marine Fisheries Service approximate these estimates (Table II-108. Fishing gear and methods of harvest are discussed in a following section on a species-specific basis.

Table II-108.
Number of Commercial Fishermen by State
(Part-time and Full-time*)

	1970	1971	1972	1973	1974
Rhode Island	1,893	2,014	1,720	2,088	2,268
Connecticut	872	801	800	823	785
New York	5,273	5,211	5,360	5,627	5,364
New Jersey	2,705	2,680	2,720	2,693	2,942
Delaware	623	714	660	620	529
Maryland	11,668	13,928	15,000	13,850	14,250
Virginia	7,404	4,948	5,050	6,153	6,249
T O T A L	30,438	30,296	31,310	31,854	32,387

* Full-time commercial fishermen--50 percent or more of working year is spent in commercial fishing activity.

Part-time commercial fishermen--50 percent or less of working year is spent in commercial fishing activity.

(Sources: National Marine Fisheries Service, 1970, 1971, 1972, 1973, 1974)

Mariculture

The use of coastal areas in the Mid-Atlantic for mariculture is minimal except for oyster culture in Long Island, Delaware, and Chesapeake Bay (Saila and Pratt, 1973). Oyster culture in the region involves cultivation of selected strains with suspension raft cultures. It is expected that there will be increasing activity in mariculture in this region, especially for shellfish species which are of higher economic value than finfish (Saila and Pratt, 1973). Potential candidates for mariculture include oysters, scallops, clams, and some crustacean and fish species (Saila and Pratt, 1973). Gates and Matthiessen (1971) and Scott (1970) discuss the economics of mariculture.

Potentially Important Species

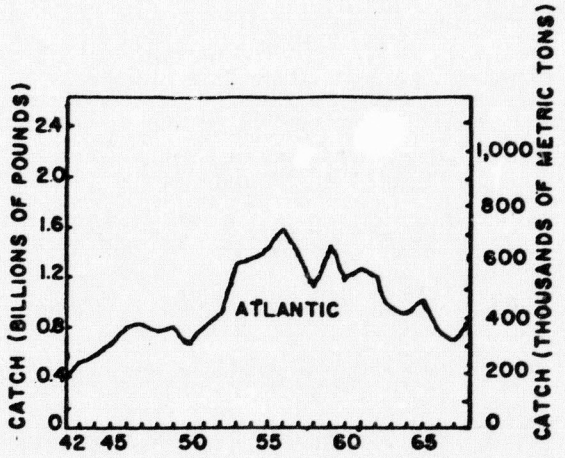
Several species in the area are potentially important commercial species. The dogfish (*Squalus acanthias*), the rock crabs (*Cancer borealis* and *C. irroratus*), and the red crab (*Geryon quinquidens*) are presently harvested, however, but it is expected that the effort for these species will increase. Alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), and various squids (*Loligo* sp.) are harvested extensively in the area by foreign fisheries. Domestic effort for these species is also expected to increase.

Biographical Data for Selected Species[1]

Atlantic menhaden (Brevoortia tyrannus). Menhaden occur in dense schools and are harvested primarily by purse seines in shallow, coastal waters. Fishing takes place from May to October. Although more pounds of menhaden are caught per year than any other species, total catch has declined in recent years. There is evidence that stocks are over-exploited and that the spawning stock is below optimum size (Henry, 1971). Figure II-74 and Table II-109 illustrate catch trends.

Figure II-74.

Catch Trend of Menhaden



(Adapted from Saila and Pratt, 1973)

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[1]Distributionsof these species are indicated on Visual No. 4 in their general location in relation to the 154 tracts of this lease sale proposal.

Table II-109.

Fish Landings by State
Brevoortia tyrannus
Atlantic Menhaden
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	9,398	128	742	30,728	--	3,837	445,960	490,793
	$ 120	$ 3	$ 34	$ 592	--	$13,920	$ 7,524	$ 22,193
1971	19,228	353	999	60,583	--	5,957	394,144	481,264
	$ 209	$ 18	$ 37	$ 1,045	--	$ 119	$ 6,431	$ 7,859
1972	18,403	369	1,775	138,476	29	7,104	549,396	715,552
	$ 214	$ 18	$ 53	$ 2,262	$ 1	$ 142	$ 9,179	$ 11,869
1973	15,962	576	1,734	154,483	33	9,657	495,963	678,408
	$ 304	$ 29	$ 52	$ 3,939	$ 1	$ 216	$ 20,396	$ 24,937

Stenotomus chrysops
Scup (Porgy)
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	2,937	100	1,215	3,116	--	5	4,154	11,527
	$ 755	$ 29	$ 349	$ 618	--	$ 1	$ 512	$ 2,264
1971	2,736	108	1,321	2,068	--	27	1,912	8,172
	$ 776	$ 31	$ 404	$ 442	--	$ 4	$ 209	$ 1,866
1972	2,338	57	1,320	3,647	--	--	1,298	8,660
	$ 608	$ 14	$ 442	$ 679	--	--	$ 152	$ 1,895
1973	3,321	191	2,904	2,970	--	1	825	10,212
	$ 843	$ 49	$ 1,035	$ 773	--	--	$ 156	$ 2,856

Menhaden migrate extensively. They move northward in the spring and summer and southward in the fall. They spawn in oceanic waters over the Continental Shelf with larvae entering estuaries (Saila and Pratt, 1973).

Scup (Porgy) Stenotomus chrysops. Scup inhabit inshore areas in the Mid-Atlantic and spawn during the summer months. They winter in areas farther north and south. Harvests in previous years have fluctuated greatly but have decreased consistently in recent years. Fluctuations in catch are thought to be due to year class success (Neville et al., 1939). Water temperatures affect the schooling characteristics of this species and therefore are thought to affect this trawling industry. Table II-109 summarizes catch trends for recent years.

Hard clams--quahog (Mercenaria mercenaria and M. campechiensis). The northern hard clam (M. mercenaria) is coastal and distributed throughout the region, while the southern quahog (M. campechiensis) is oceanic and reaches as far north as New Jersey (Merrill and Ropes, 1967; Miller et al., 1970). Hard clams spawn in their second year from spring to summer and become harvestable at two to three years. They are harvested most frequently by dredging. Table II-110 and Figures II-75 and II-76 summarize catch records.

Table II-110.

Fish Landings by State
Mercenaria mercenaria
Quahogs (hard)
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	2,515	591	7,906	2,576	89	568	1,257	15,502
	$ 979	$ 271	$ 8,977	$ 1,544	$ 56	$ 317	$ 823	$ 12,967
1971	2,563	276	11,549	2,476	113	331	1,837	16,306
	$ 1,072	$ 206	$ 10,757	$ 1,679	$ 75	$ 192	$ 1,398	$ 15,379
1972	2,272	396	8,500	2,196	90	1,511	1,336	16,301
	$ 1,392	$ 212	$ 13,234	$ 1,579	$ 69	$ 1,216	$ 1,129	$ 18,831
1973	2,380	241	7,246	1,894	63	68	1,354	13,246
	$ 1,329	$ 101	$ 10,911	$ 1,641	$ 54	$ 38	$ 1,258	$ 25,332

Spisula solidissima
Surf Clam
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	77	--	4,182	39,669	8,734	13,681	889	67,232
	$ 16	--	$ 490	$ 4,685	$ 935	$ 1,475	$ 110	$ 7,711
1971	155	--	3,688	28,721	7,694	7,752	4,507	52,517
	$ 32	--	$ 438	$ 3,877	$ 1,030	$ 981	$ 527	$ 6,885
1972	131	--	2,713	21,332	8,551	7,331	23,384	63,442
	$ 27	--	$ 313	$ 2,780	$ 1,132	$ 1,150	$2,528	$ 7,930
1973	17	--	3,319	21,588	6,630	7,448	43,323	82,325
	$ 4	--	$ 413	$ 2,709	$ 781	$ 1,167	$4,777	$ 9,851

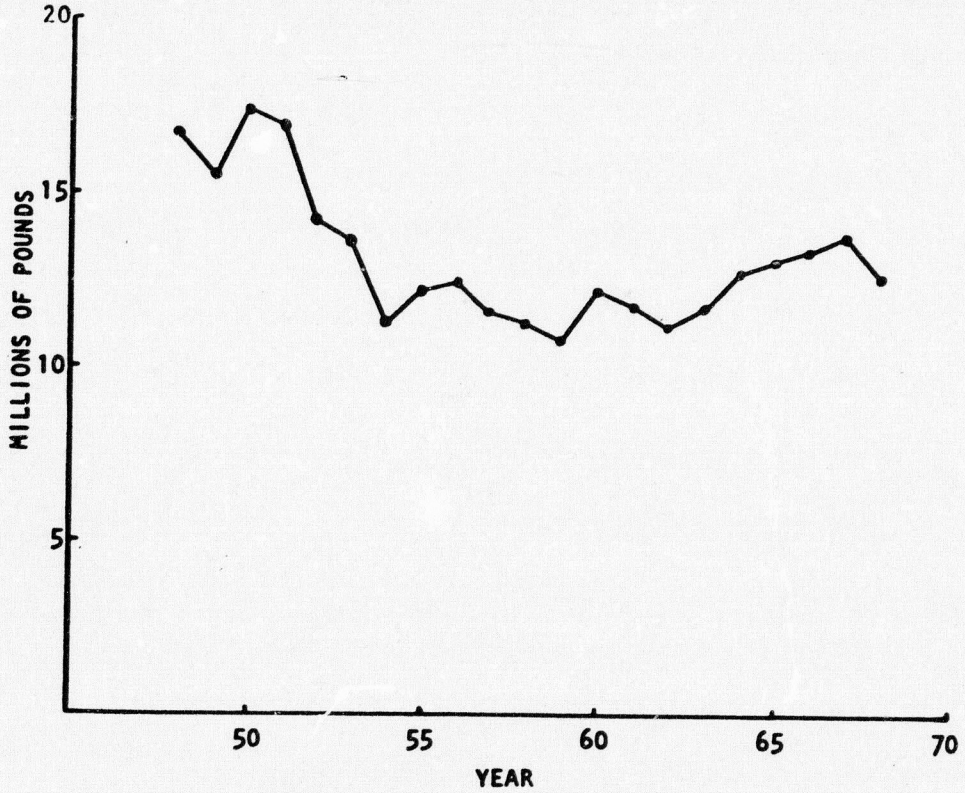

Figure II-75. Hard clam catch (meats) in Rhode Island to Virginia from 1948-1968 (Saila and Pratt, 1973)

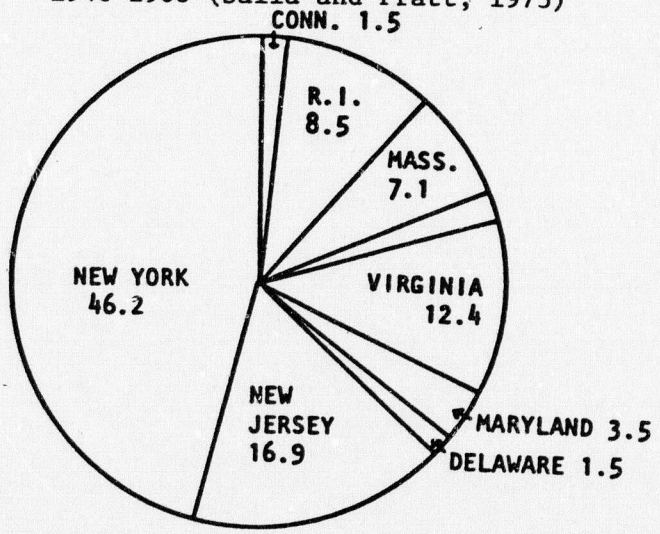

Figure II-76. United States hard clam landings, percentage by state in 1968 (Saila and Pratt, 1973)

Surf clam (Spisula solidissima). The surf clam is the largest bivalve in the Mid-Atlantic and occurs as far south as Cape Hatteras (Saila and Pratt, 1973). Spawning can occur during summer and late fall (Ropes, Chamberlin and Merrill, 1969). They reach harvestable size (3 inches) in five to six years and are harvested primarily by hydraulic dredges. Surf clams provide over 60 percent of all clam meats used in the United States. The surf clam is of considerable significance for New Jersey and in recent years Virginia (Table II-110). The Atlantic surf clam fishery is documented by Groutage and Barker, 1967; Yancy, 1968; Yancy and Welch, 1968; Ropes, Chamberlin and Merrill, 1969; and Barker and Ropes, 1971.

Eastern oyster (Crassostrea virginica), The eastern oyster is distributed throughout the area and occupies intertidal, flat, and offshore bar areas (Hidu, 1968). Lossanoff and Nomejko (1951) report several physiological subspecies depending on estuarine isolation. They generally settle on hard rock, hard mud, or other oysters (Galtsoff, 1964). C. virginica is euryhaline and survive salinities from 3°/oo to 40°/oo. Butler (1949), however, reports their vulnerability to floods and high mortalities caused by severe storms and subsequent siltation.

Commercial oyster beds are usually transferred as cultch or seedlings after spring silting. They reach marketable size in four to five years in the Mid-Atlantic area. C. virginica is limited by factors other than abrupt and dramatic changes in salinity. Predators, such as Cliona (boring sponge), Diplothyria smithii (boring clam), Polydora (mudworm), Urosalpinx cinerea (gastropod), Eupleura caudata (gastropod), Asterias forbesi (echinoderm), Callinectes sapidus, and Cancer irroratus (crabs), have been reported as being very destructive (Carriker, 1955; Warburton, 1958; Galtsoff, 1964; Shaw and Griffith, 1967; MacKenzie, Jr., 1970a, 1970b). The main concern, however, has been the oyster parasite Minchinia nelsoni (M.S.X.). Entire oyster populations have been destroyed in Delaware Bay and to a lesser extent, in Chesapeake Bay (Haskins et al., 1965; Haskins et al., 1966; Mauer et al., 1971). Additional difficulties are posed by pollution and marshland development. Saila and Pratt (1973) cite industrial, radioactive, thermal, and pesticide pollution as having destroyed oyster populations in certain areas.

Oyster production has been declining since 1880 (Saila and Pratt, 1973). Table II-111 summarizes recent statistics. Harvesting techniques include the use of dredges, rakes, and tongs.

Table II-111.

Fish Landings by State
Crassotrea virginica
American oyster
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	7	125	520	677	216	16,625	8,042	26,112
	$ 9	$ 228	$ 1,074	$ 557	$ 133	$ 9,652	$ 5,426	$ 17,079
1971	3	133	779	871	315	1,363	8,442	11,906
	$ 5	$ 231	$ 1,682	$ 708	$ 203	$ 1,021	$ 5,509	$ 9.359
1972	3	80	1,112	1,714	509	19,052	5,012	27,479
	$ 5	$ 155	$ 2,466	$ 1,370	$ 413	$ 12,929	$ 2,967	$ 20,305
1973	--	221	1,392	1,397	392	20,422	4,978	28,802
	--	$ 514	$ 3,258	$ 1,329	$ 326	$ 13,588	$ 16,745	$ 35,760

Placopecten magellanicus
Sea Scallop
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	25	1	899	101	--	--	750	1,776
	$ 34	$ 1	$ 1,173	$ 132	--	--	$ 995	$ 2.335
1971	10	--	546	112	--	--	546	1,214
	$ 14	--	$ 843	$ 162	--	--	$ 802	$ 1,821
1972	20	--	315	247	--	--	961	1,543
	$ 39	--	$ 644	$ 503	--	--	$ 1,856	$ 3,042
1973	22	--	153	476	--	--	773	1,592
	$ 38	--	$ 307	$ 832	--	--	$ 1,347	$ 2,919

Sea scallop (Placopecten magellanicus). Sea scallops range throughout the Mid-Atlantic area. The most important commercial beds are located off New Jersey up to Hudson Canyon at depths of 80 to 100 meters (Posgay, 1957; Merrill, 1962). Scallops spawn in their third or fourth year according to Baird (1967) and seem to be triggered by a rise in termperature.

Scallops are harvested by trawls and dredges. Table II-111 summarizes recent harvests.

Blue crab (Callinectes sapidus). The blue crab has a range throughout the area (Piers, 1923; Rees, 1969). It occurs in shallow waters, such as bays, sounds, and estuaries. The blue crab at the present time supports the largest crab industry in the United States; it presently does not exist north of New Jersey and is concentrated in the Chesapeake region.

C. sapidus can osmoregulate over a wide salinity range. While males remain brackish, females migrate between saline and brackish waters, depending on time of year (mating period). They seem to be fairly resistant to organic pollution by their continued presence in Raritan Bay. Rawls (1965), however, reports their sensitiveness to herbicides.

Trotlines, pots, and dredges are used to harvest blue crabs. Table II-112 summarizes their catch.

Table II-112.

Fish Landings by State

Callinectes sapidus

Blue crab

(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	--	1	--	751	608	26,514	43,326	71,200
	--	$ 1	--	$ 113	$ 107	$ 2,757	$ 2,725	$ 5,703
1971	--	1	--	1,103	1,014	27,603	48,499	78,220
	--	$ 1	--	$ 172	$ 203	$ 3,201	$ 4,001	$ 7,578
1972	--	--	--	1,437	2,552	25,055	49,412	78,456
	--	--	--	$ 327	$ 672	$ 3,085	$ 4,334	$ 8,418
1973	--	--	--	2,572	2,391	21,,052	37,729	63,744
	--	--	--	$ 663	$ 666	$ 3,550	$ 4,560	$ 9,439

Homarus americanus

American Lobster

(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	5,195	673	1,647	1,836	--	22	229	9,602
	$ 5,212	$ 715	$ 1,847	$ 1,739	--	$ 20	$ 149	$ 9,682
1971	5,389	523	1,790	1,323	30	28	234	9,317
	$ 6,038	$ 657	$ 2,054	$ 1,460	$ 41	$ 28	$ 200	$ 10,478
1972	3,361	540	1,145	1,308	22	21	884	7,281
	$ 4,319	$ 777	$ 1,825	$ 1,828	$ 36	$ 26	$ 1,028	$ 9,839
1973	2,630	544	893	1,363	30	24	199	5,683
	$ 4,019	$ 840	$ 1,428	$ 2,234	$ 51	$ 33	$ 285	$ 8,890

American lobster (Homarus americanus). The American lobster occurs southward from Labrador to North Carolina. In the Mid-Atlantic area, it is restricted to deeper waters due to higher temperatures and lack of suitable substrates. Their density and distribution also seem to be related to the availability of shelter (rocks, burrows, etc.). Artificial shelters are reported to increase the carrying capacity in given areas (Stewart, 1972).

Inshore populations of lobster are considered to be nonmigratory but undergo seasonal movement. Stewart (1972) describes the movement of the inshore population. Saila and Flowers (1969) concluded that the offshore population is independent from inshore populations, and further studies by Cooper and Uzmann (1971) concluded that the offshore population undergoes migration toward shallow water in spring and summer and return to deeper waters in fall and winter. Additional life history data is documented by Herrick (1911), Dow et al. (1966), Saila and Flowers (1968), Cobb (1968, 1969), Cooper (1970), and Lewis (1970).

An offshore fishery has developed over the past fifteen years which in 1968 provided for over 60 percent of the Mid-Atlantic Bight catch. Most of the catch, however, is obtained north of the Bight and is illustrated in Figure II-77(Saila and Pratt, 1973). In 1970, offshore landings accounted for 37 percent of the total United States catch

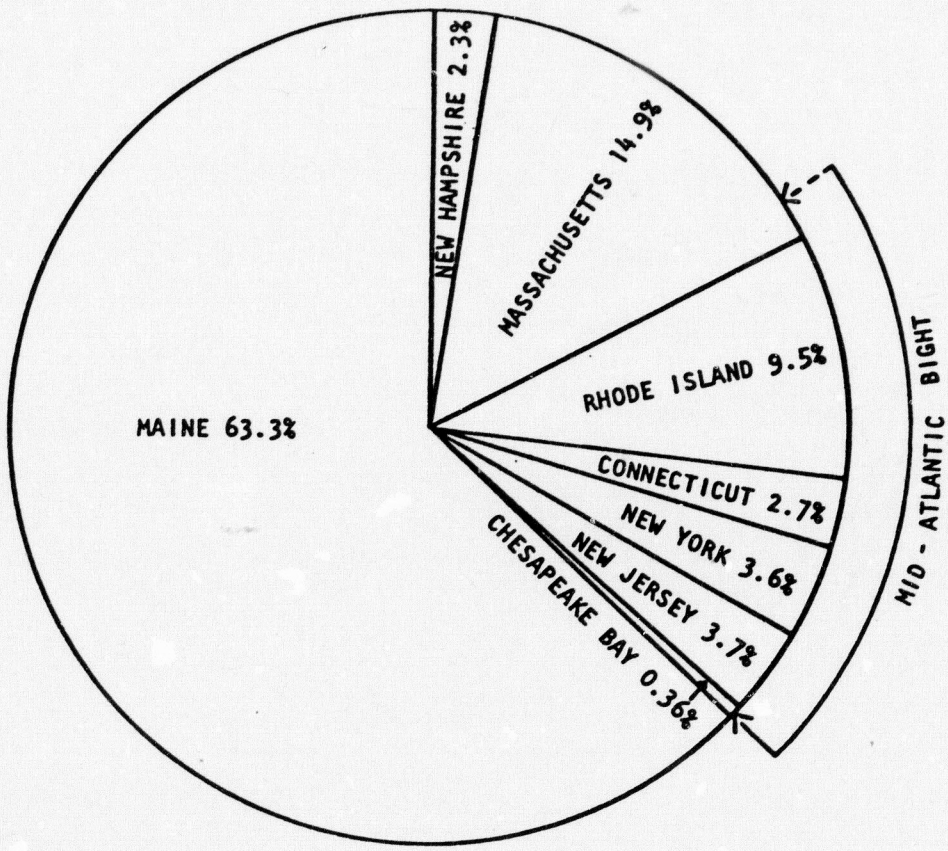

Figure II-77. United States lobster landings, percentage by state in 1968 (Saila and Pratt, 1973)

and has been increasing since 1951, primarily due to growth of the industry south of Cape Cod. Lobsters are harvested by trawls and pots. Figures II- 77 and II-78 and Table II-112 summarize lobster catch statistics.

Summer flounder (Paralichthys dentatus). The summer flounder or fluke is a shallow water species during summer and inhabits deeper waters during winter. Spawning occurs during the fall with evidence that the principal nurseries are located in the southern portion of the Bight (Saila and Pratt, 1973).

The fluke flounder is caught during the entire year. It is primarily a sport fishery inshore with some taken commercially by traps and seines. The offshore fishing is done primarily with otter trawls. Table II- 113 summarizes recent harvests.

Winter flounder (Pseudopleuronectes americanus). The winter flounder or blackback is a coastal species ranging throughout the area. It is an important sport and commercial fisheries species. P. americanus spawn in late winter and spring in bays and estuaries. After hatching, young flounder remain in coastal areas for over a year. Adult migrations are short, seasonal ones. After spawning, adults return to deeper offshore waters as water temperature becomes high in bays. Table II-113 summarizes catch statistics for the species.

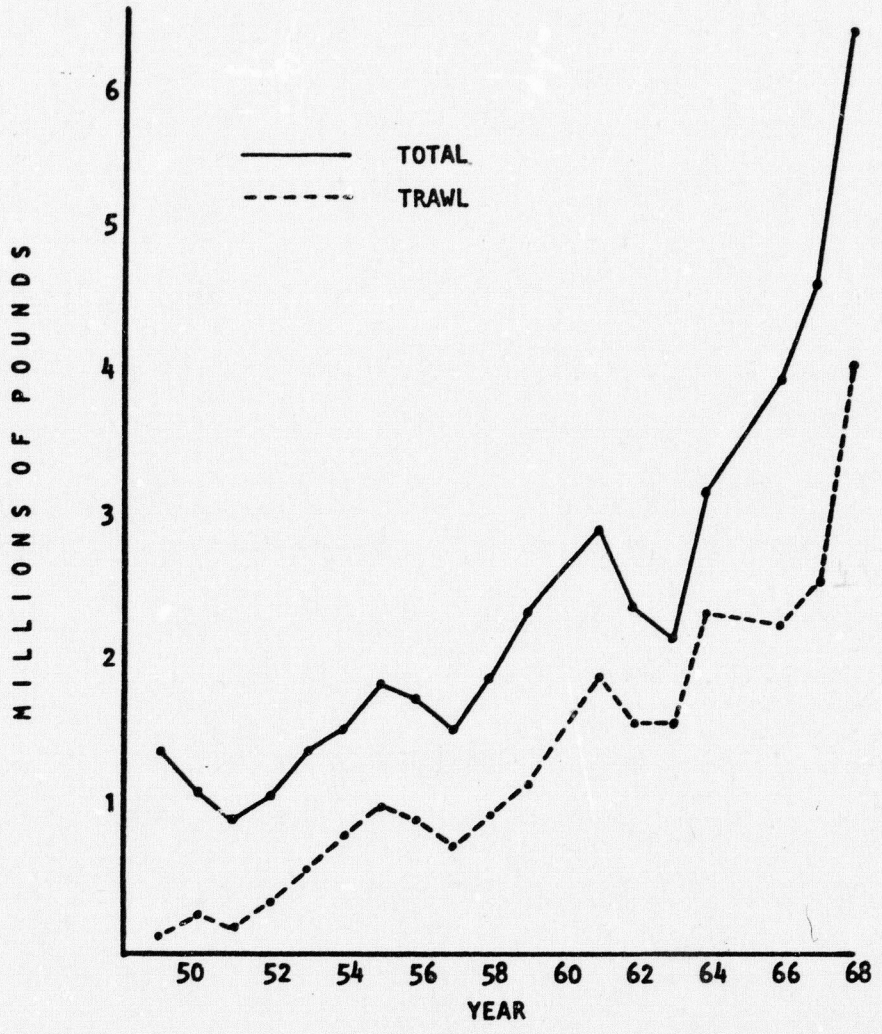

Figure II-78. Landings of northern lobster from Rhode Island, Connecticut, New York, New Jersey, and the Chesapeake region (Saila and Pratt, 1973)

Table II-113.

Fish Landings by State

Paralichthys dentatus

Summer Flounder (fluke flounder)

(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	259	23	900	1,958	--	371	2,146	5,657
	$ 129	$ 11	$ 358	$ 686	--	$ 93	$ 611	$ 1,888
1971	275	34	1,090	1,850	--	296	1,715	5,260
	$ 143	$ 17	$ 360	$ 673	--	$ 101	$ 504	$ 1,798
1972	275	7	1,101	1,852	--	277	1,856	5,368
	$ 148	$ 4	$ 439	$ 738	--	$ 103	$ 589	$ 2,021
1973	639	52	1,826	3,092	--	495	3,232	9,336
	$ 301	$ 24	$ 926	$ 1,103	--	$ 152	$ 870	$ 3,376

Pseudopleuronectes americanus

Winter flounder (Blackback flounder)

(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	5,301	789	1,692	146	3	21	122	8,074
	$ 620	$ 92	$ 109	$ 10	$ 1	$ 2	$ 10	$ 977
1971	5,275	817	1,660	79	5	18	45	13,174
	$ 650	$ 101	$ 125	$ 8	$ 1	$ 2	$ 7	$ 894
1972	4,634	38	1,429	94	2	3	20	6,230
	$ 806	$ 6	$ 123	$ 9	$ 1	$ --	$ 3	$ 837
1973	4,414	845	1,160	159	2	2	2	6,584
	$ 877	$ 168	$ 141	$ 16	$ 1	$ 1	$ 1	$ 1,205

The blackback trawl fishery is an old and established one. There is no current evidence that the species is overexploited; however, their breeding grounds should be adequately protected.

Silver hake (Merluccius bilinearis). The hake or whiting fishery is primarily inshore in the Mid-Atlantic. Sarnits and Sauskan (1967) report that distributions offshore are governed by water temperature. Colder waters do not favor spawning and often result in the disappearance of this species in offshore waters.

Whiting are harvested primarily by draggers. Table II-114 summarizes recent catch.

Bluefish (Pomatomus saltatrix). Bluefish are a warm water species and are found from the immediate coast to the edge of the continental shelf. Annual migrations within the Mid-Atlantic Bight are due to seasonal changes in the water temperature of coastal areas. They summer in coastal waters and retreat to deeper waters in winter, although their wintering grounds have never been fully observed. Their stay in inshore waters seems to be interrupted by the spawning period when they return to the outer shelf (Saila and Pratt, 1973). Larval bluefish are most common in offshore waters, and juveniles are found predominantly in waters adjacent to the coast.

Bluefish are valuable as a sport and commercial fish. Their center of distribution is the Mid-Atlantic and has historically been characterized by wide fluctuations in relative abundance for unknown reasons. Table II-114 summarizes commercial harvests.

Table II-114.

Fish Landings by State

Merluccius bilinearis
Whiting - Silver Hake
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	3,597	88	1,020	3,301	--	32	32	8,070
	$ 322	$ 8	$ 114	$ 382	--	$ 4	$ 3	$ 833
1971	2,910	289	1,058	3,948	--	6	94	8,305
	$ 228	$ 16	$ 95	$ 375	--	$ 1	$ 7	$ 722
1972	2,753	83	2,631	5,440	--	8	10	10,925
	$ 285	$ 5	$ 195	$ 453	--	$ 1	$ 1	$ 940
1973	3,094	21	1,931	6,450	2	4	12	11,514
	$ 310	$ 2	$ 211	$ 868	--	$ 1	$ 3	$ 1,395

Pomatomus saltatrix
Bluefish
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	323	85	1,602	1,064	--	69	646	4,329
	$ 32	$ 13	$ 165	$ 109	--	$ 7	$ 61	$ 387
1971	271	83	1,211	979	--	141	610	3,295
	$ 23	$ 9	$ 148	$ 126	--	$ 14	$ 61	$ 381
1972	313	49	1,003	812	1	58	1,216	3,452
	$ 50	$ 9	$ 162	$ 124	--	$ 6	$ 97	$ 448
1973	278	96	1,412	887	3	276	9,269	12,221
	$ 40	$ 17	$ 160	$ 133	$ 1	$ 23	$ 308	$ 682

Atlantic mackerel (Scomber scombrus). The Atlantic mackerel spawns in early spring and summer. It is a pelagic species and spawns throughout the area, maturing in two years. Mackerel gather in dense schools in spring in coastal waters and later retreat to deeper waters but are not known for extensive coastal migrations. Their numbers are known to fluctuate widely from year to year for unknown reasons. Catch statistics are provided in Table II-115.

Weakfish (Cynoscion regalis). Weakfish are valuable both as a sport and commercial fish. It is considered to be a coastal species in that most of its catch occurs there. During winters, it moves into deeper waters. Its center of distribution is along the Mid-Atlantic coast but weakfish range as far south as Florida.

Weakfish spawn during the summer months in estuaries or close to shore. Catch of this species fluctuates widely from year to year. Statistics are provided in Table II-115.

Striped bass (Roccus saxatilis). The striped bass is valuable as a sport and commercial species. It is dependent on a few large rivers for spawning, with the greatest number depending on the Chesapeake Bay system (Figure II- 79). Over 80 percent of all commercial landings are taken within the Mid-Atlantic Bight region. Its center of distribution for the Atlantic coast is the Mid-Atlantic Bight even though it ranges further north and south (Merriman, 1941).

Table II-115.

Fish Landings by State

Scomber scombrus

Atlantic Mackerel
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	556	16	368	1,313	--	3	273	2,529
	$ 39	$ 2	$ 31	$ 61	--	$ 1	$ 14	$ 148
1971	179	11	502	979	--	10	124	1,805
	$ 16	$ 2	$ 30	$ 126	--	$ 1	$ 7	$ 182
1972	748	8	544	1,512	--	7	55	2,874
	$ 47	$ 1	$ 46	$ 105	--	$ 1	$ 5	$ 205
1973	1,297	22	323	1,155	--	20	14	2,831
	$ 142	$ 4	$ 50	$ 94	--	$ 4	$ 2	$ 296

Cynoscion regalis

Weakfish (Grey)
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	21	1	296	1,961	147	322	2,141	4,889
	$ 4	$ 1	$ 61	$ 149	$ 31	$ 30	$ 253	$ 528
1971	183	17	1,279	3,099	213	408	2,333	7,532
	$ 20	$ 3	$ 205	$ 254	$ 41	$ 37	$ 270	$ 830
1972	180	1	1,831	3,179	406	313	2,615	8,525
	$ 28	$ 1	$ 292	$ 333	$ 43	$ 34	$ 285	$ 1,016
1973	178	7	1,270	2,563	334	540	5,099	9,991
	$ 40	$ 2	$ 223	$ 339	$ 84	$ 75	$ 673	$ 1,436

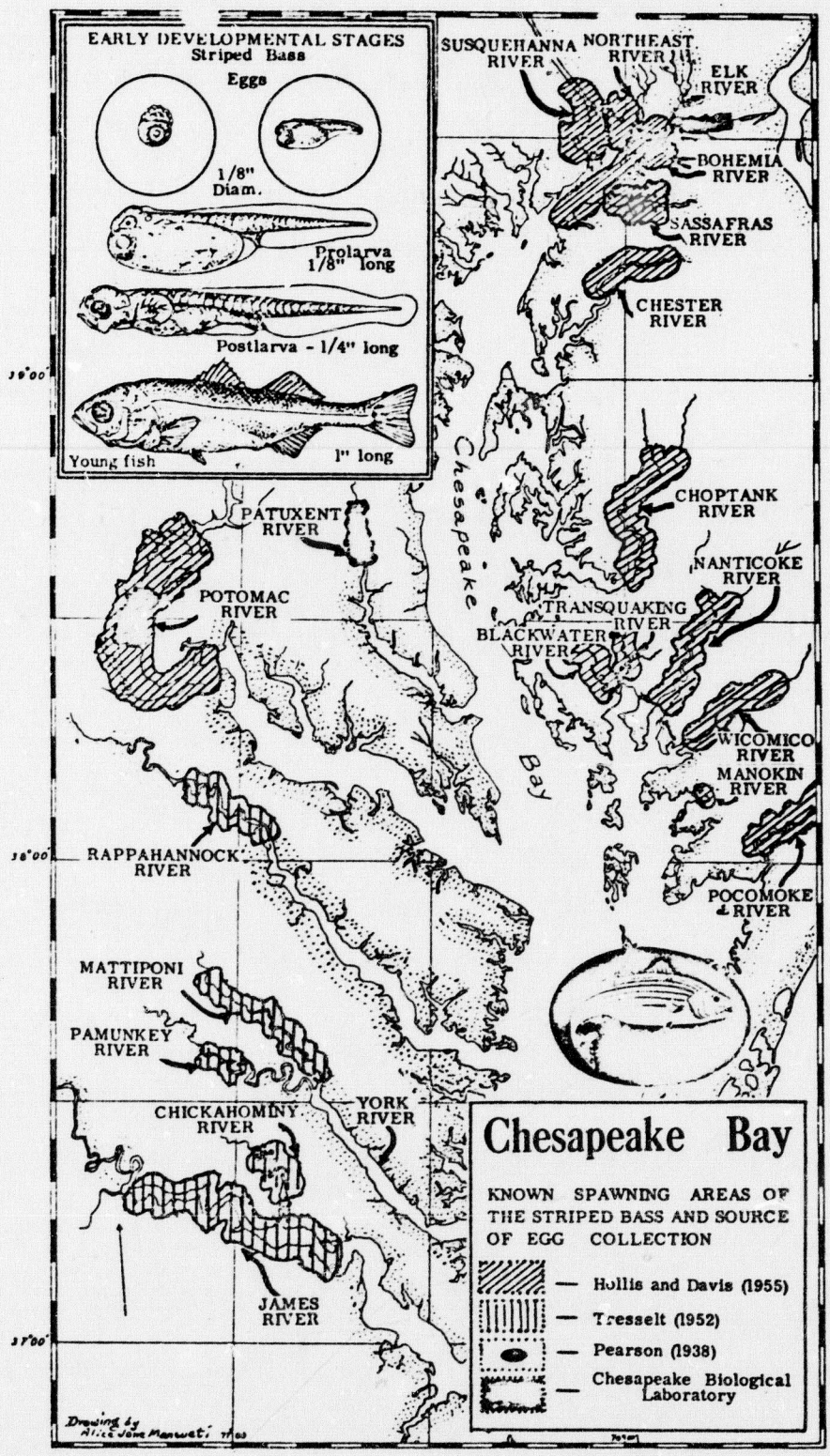

Figure II-79. Ranges and locations of some of the principal spawning areas of striped bass, or rock, in Chesapeake Bay, with illustrations of selected early developmental stages.

(Mansuetti, 1963)

The present number of rivers along the Atlantic coast which supports spawning populations of striped bass represents only a portion of those that once did (Merriman, 1941). The Hudson River and the Chesapeake Bay river system currently support the largest spawning populations (Wallace and Neville, 1972; Clark, 1968).

Striped bass seldom occur far from shore. They ascend rivers to spawning grounds in late spring to summer depending on latitude which is attuned to water temperatures. Females are mature by their sixth year and males by the end of their second year (Merriman, 1941). Juveniles usually remain in estuaries until they are two years old, and then they assume the migratory habits of adults (Vladykov and Wallace, 1938). Table II-116 shows striped bass which were tagged as juveniles in the Nanticoke and Chaptank Rivers, Maryland, and which were captured from the offshore waters from Rhode Island to Virginia.[1]

Extensive nonspawning migrations are made by this species. In late winter and early spring they migrate northward to Canada and return in later summer (Merriman, 1941).

The commercial fishery for striped bass is centered in the Chesapeake Bay region. Commercial catch is equalled by sports catch. Commercial data is presented in Table II-117.

Alewife (Alosa pseudoharengus). The alewife is an anadromous herring distributed along the entire coast. They enter fresh water in spring to early summer to spawn. Little is known about the major portion of

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[1]Benjamin Florence, State of Maryland Fisheries Administration, Annapolis, Maryland, personal communication, March 1976.

TABLE II- 116.

TAG RETURNS BY STATE OF 1,375 STRIPED BASS WHICH SPAWNED IN THE NANTICOKE AND CHOPTANK RIVERS, MARYLAND. RESULTS FROM NORTH CAROLINA AND MASSACHUSETTS ARE NOT INCLUDED. (FLORENCE, UNPUBLISHED)

Location Tagged	Date Tagged	Sex	Size	Recaptured	Date Recaptured	Method
Virginia Returns						
Nanticoke	4/13/73	F	15 lb.	York River	4/17/74	Fyke
Choptank	5/10/73	F	17 lb.	Norfolk	6/11/73	Hook & Line
Nanticoke	4/28/72	F	24 lb.	Virginia Beach	12/19/74	Gill Net
Maryland Returns						
Choptank	4/18/72	M	21 lb.	Choptank	4/12/73	
Nanticoke	1972	F	42 in.	Nanticoke	4/16/73	
Nanticoke	4/9/72	F	18 lb.	Pocomoke Sound	4/16/74	
Choptank	4/21/72	F	36 lb.	Choptank	4/23/73	
Choptank	4/18/72	M	17 lb.	Choptank	4/27/73	
Choptank	4/18/72	F	19 lb.	Choptank	5/1/73	
Choptank	5/2/72	F	22 lb.	Choptank	5/3/73	
Nanticoke	4/12/73	F	19 lb.	Bay Bridge	6/30/73	Hook & Line
Choptank	5/3/73	F	22 lb.	Bay Bridge	7/21/73	H&L
Nanticoke	4/24/73	F	20 lb.	Bay Bridge	7/22/74	H&L
	4/72	F	27 lb.	Bay Bridge	8/14/73	H&L
Nanticoke	4/12/72	F	37 lb.	Bay Bridge	8/22/72	H&L
Nanticoke	4/13/72	F	23 lb.	Bay Bridge	8/22/72	H&L
Nanticoke	4/11/73	M	17 lb.	Bay Bridge	8/25/73	H&L
Choptank	4/18/72	M	19 lb.	Severn River	9/5/72	H&L
New Jersey Returns						
Nanticoke	4/7/73	F	26 lb.	Sandy Hook	6/7/73	H&L
Nanticoke	4/14/72	M	22 lb.	Monmouth Rocks	6/3/73	H&L
Choptank	4/20/72	F	23 lb.	Seabright	6/3/72	H&L
Choptank	4/18/72	F	36 lb.	Highlands	6/7/72	H&L
Nanticoke	4/13/73	F	70 lb.	Sandy Hook	6/9/73	H&L
Nanticoke	4/24/72	F	40 lb.	Bay Head	6/13/73	H&L
Nanticoke	4/3/73	F	29 lb.	Sandy Hook	6/22/73	H&L
Choptank	5/3/72	F	23 lb.	Sandy Hook	7/4/72	H&L
Choptank	4/20/72	F	20 lb.	Sandy Hook	7/15/72	H&L
Choptank	4/21/72	F	40 lb.	Highlands	7/22/72	H&L
Nanticoke	4/20/72	F	33 lb.	Long Beach Island	10/19/72	H&L
Nanticoke	4/24/72	F	18 lb.	Romer Shoal	10/28/73	H&L
Nanticoke	5/1/72	F	22 lb.	Island Beach	10/30/73	H&L
Nanticoke	4/12/73	F	40 in.	Harvey Cedars	11/5/73	Trawl
New York Returns						
Nanticoke	4/12/72	F	30 lb.	Long Beach	6/2/73	H&L
Nanticoke	5/1/72	F	23 lb.	Amagansett	6/6/72	Haul Seine
Choptank	4/24/73	F	49 lb.	Sag Harbor	6/15/73	H&L
Nanticoke	4/13/73	F	40 lb.	Rockaway Beach	6/23/73	H&L
Choptank	5/4/73	F	28 lb.	Montauk	6/25/73	H&L
Nanticoke	4/21/72	F	29 lb.	Fishers Island	6/26/72	H&L
Nanticoke	4/28/72	F	24 lb.	Montauk	6/27/73	H&L
Choptank	5/4/73	F	23 lb.	Amagansett	7/18/73	Haul Seine
Choptank	5/2/72	F	44 lb.	Jones Inlet	7/20/73	H&L
Choptank	4/18/72	F	44 lb.	East Hampton	7/26/73	H&L
Choptank	4/18/72	M	20 lb.	Riverhead	8/18/72	H&L
Nanticoke	4/13/73	F	23 lb.	Riverhead	8/28/73	H&L
Nanticoke	4/12/72	F	35 lb.	Montauk	9/21/72	H&L
Nanticoke	4/14/73	F	24 lb.	Fishers Island	9/28/73	H&L
Choptank	5/2/72	F	22 lb.	Montauk	10/4/72	H&L
Nanticoke	4/14/73	F	36 lb.	Montauk	10/16/73	H&L
Nanticoke	4/13/72	F	50 lb.	Sag Harbor	10/28/72	H&L
Choptank	4/21/72	F	35 lb.	Plum Is.	7/24/75	H&L
Nanticoke	4/13/73	F	35 lb.	Plum Is.	8/14/75	H&L
Connecticut Returns						
Nanticoke	4/14/73	F	32 lb.	E. Norwalk Is.	5/22/73	H&L
Nanticoke	4/15/73	F	42 lb.	Norwalk	6/11/74	H&L
Nanticoke	4/1/73	F	21 lb.	New London	6/26/73	H&L
Nanticoke	4/13/73	F	37 lb.	Groton	7/1/73	H&L
Nanticoke	4/14/73	F	21 lb.	Rowayton	7/1/73	H&L
Nanticoke	4/21/73	F	40 lb.	Greenwich	7/24/73	H&L
Nanticoke	4/21/73	F	39 lb.	Fields Point	7/24/73	H&L
Choptank	5/3/72	F	22 lb.	Waterford	8/10/72	H&L
Nanticoke	4/21/72	F	34 lb.	Milford	10/23/73	H&L
Nanticoke	4/13/73	F	27 lb.	Milford	10/29/73	H&L
Nanticoke	4/12/72	F	42 lb.	New London	8/27/75	H&L
Rhode Island Returns						
Choptank	4/21/72	F	45 lb.	Point Judith	5/24/72	Trawl
Nanticoke	4/28/72	F	37 lb.	Prudence Is.	5/30/72	H&L
Nanticoke	4/13/73	F	27 lb.	Prudence Is.	5/31/72	H&L
Nanticoke	4/7/73	F	38 lb.	Watch Hill	6/4/73	H&L
Nanticoke	4/18/73	F	30 lb.	Providence Pt.	6/14/73	H&L
Choptank	5/3/72	F	20 lb.	Watch Hill	7/3/73	H&L
Nanticoke	4/13/73	F	15 lb.	Narrow R.	7/13/73	H&L
Nanticoke	4/13/73	F	41 lb.	Point Judith	7/31/74	H&L
Choptank	4/17/72	M	17 lb.	Narragansett Bay	8/19/73	H&L
Nanticoke	4/12/73	F	53 lb.	Quonochontaug	8/29/73	H&L
Nanticoke	4/28/72	F	14 lb.	Narragansett Bay	9/2/73	H&L
Nanticoke	4/3/73	M	30 lb.	Watch Hill	9/8/73	H&L
Nanticoke	4/3/73	M	20 lb.	Providence Pt.	9/15/73	H&L
Nanticoke	4/12/73	F	22 lb.	Point Judith	9/17/73	H&L

Table II-117.

Fish Landings by State

Roccus saxatilis
Striped Bass
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	84	--	1,338	223	54	3,977	1,782	7,468
	$ 25	--	$ 363	$ 48	$ 12	$ 870	$ 370	1,688
1971	131	--	1,184	290	39	2,743	1,221	5,608
	$ 39	--	$ 329	$ 86	$ 9	$ 864	$ 288	$ 1,615
1972	309	--	818	372	248	3,229	3,244	8,220
	$ 115	--	$ 264	$ 111	$ 67	$ 930	$ 409	$ 1,896
1973	623	--	1,674	766	586	4,976	2,888	11,513
	$ 220	--	$ 630	$ 211	$ 155	$ 1,554	$ 770	$ 3,540

Alosa pseudoharengus
Alewife
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	144	122	11	8	--	2,064	19,045	21,394
	$ 3	$ 3	$ 1	$ 1	--	$ 52	$ 393	$ 453
1971	53	25	--	10	--	2,811	10,291	13,190
	$ 2	$ 1	--	$ 1	--	$ 54	$ 240	$ 298
1972	34	23	1	15	--	1,689	10,450	12,212
	$ 2	$ 1	--	$ 1	--	$ 33	$ 281	$ 318
1973	--	14	22	7	--	2,031	9,269	11,343
	--	$ 1	$ 1	$ 1	--	$ 38	$ 308	$ 349

Centropristis striata
Black sea bass
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	55	1	70	308	--	202	1,481	2,117
	$ 28	--	$ 24	$ 109	--	$ 61	$ 321	$ 543
1971	39	1	55	309	30	140	658	1,231
	$ 22	--	$ 19	$ 108	$ 9	$ 45	$ 121	$ 324
1972	46	1	44	423	40	227	782	1,563
	$ 20	--	$ 16	$ 153	$ 13	$ 63	$ 173	$ 438
1973	34	1	105	694	60	207	1,283	2,384
	$ 17	--	$ 50	$ 269	$ 18	$ 66	$ 305	$ 725

their life history. Juveniles migrate to sea during their first year and remain there until sexually mature (three to four years). Alewife are plankton feeders and form large schools. They are heavily fished by foreign fisheries. Table II-117 summarizes catch statistics.

Black sea bass (Centropristes striatus). The black sea bass is a marine species and ranges from nearshore to approximately 200 m offshore depending on time of year. They are nearshore in early summer and retreat in late fall. Little is known concerning the life history of this species. Table II-117summarizes catch statistics.

The Final EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol. 1, pp. 494-500 and 700-708 presents an overview of Atlantic commercial fisheries.

Blueback herring (Alosa aestivalis). The blueback herring is similar in appearance to the alewife. In its distribution it is a more southern species but is occasionally reported as far north as the Gulf of Maine. Like the alewife, it enters streams to spawn but later in the season. After spawning it runs into areas of moderate salinity and high algal productivity where it spends its summer months as a grazing fish. It is thought that they move far offshore and winter in deeper waters (Saila and Pratt, 1973). Table II-118 summarizes domestic catch statistics. The species is extensively harvested by foreign fisheries, but figures are not available.

Table II-118.

Fish Landings by State
Alosa sp.
Blueback Herring
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	2219	4	62	406	-	1	10	2702
	$ 46	$ 1	$ 4	$ 9	$ -	$ 1	$ 1	$ 62
1971	2888	3	16	85	-	1	2450	5443
	$ 62	$ 1	$ 1	$ 2	$ -	$ 1	$ 37	$ 104
1972	5064	1	26	202	-	3	696	5992
	$ 111	$ 1	$ 2	$ 5	$ -	$ 1	$ 19	$ 139
1973	9342	-	21	114	-	15	383	9875
	$ 241	$ -	$ 2	$ 3	$ -	$ 1	$ 11	$ 258

American shad (*Alosa sapidissima*). The shad is an important sport and commercial species in the Mid-Atlantic area (Table II-119). Shad are anadromous and return to streams to spawn during the spring. They enter the estuaries of the Atlantic coast early in the year in February. Spawning occurs through April usually in tidal fresh water. After spawning, adult shad return to the ocean leaving their bay environments by early summer. Young shad remain in inlets and bays throughout the summer, some returning to the open sea in the fall, others remaining in the bay for their first winter. Immature shad remain at sea for from three to six years, until maturity, when they return again to estuaries to spawn (Lippson, 1973).

Commercial catch of shad has declined significantly in recent years. The decline is believed to be due to river obstructions, overfishing, and pollution (Saila and Pratt, 1973). Most commercial harvests take place at river mouths by seines and gill nets. It will also continue to be an important sport fishery species.

Table II-119.

Fish Landings by State
Alosa sapidissima
American Shad
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	12	173	106	195	13	1039	4112	5650
	$ 1	$ 55	$ 13	$ 27	$ 1	$ 107	$ 315	$ 519
1971	42	241	73	141	8	953	1520	2978
	$ 1	$ 67	$ 16	$ 22	$ 5	$ 124	$ 135	$ 370
1972	14	249	103	263	9	957	2057	3652
	$ 1	$ 75	$ 19	$ 34	$ 1	$ 118	$ 225	$ 533
1973	2	258	157	143	8	597	2436	3601
	$ 1	$ 73	$ 51	$ 27	$ 1	$ 105	$ 366	$ 624

Yellow-tailed flounder (Limanda ferrunginia). The yellow-tailed flounder is a shallow water flatfish common north of New Jersey. Yellow-tails spawn over the entire area of their ranges from March through August. They become sexually mature in their third or fourth year at a length of 30 cm. Bottom type is a greater determinant of distribution than temperature, and there bottomfish prefer sandy bottoms to rock or mud. Yellow-tail grounds occur on sandy bottoms in water from 150 to 200 feet deep. Yellow-tails are omnivorous (TRIGOM, 1974). Table II- 120 summarizes catch statistics.

Atlantic cod (Gadus morhua). The Atlantic cod is a large boreal, demersal member of the cod family. The cod has regular, small, well-defined spawning areas, and do not spawn below 275 feet. Cod spawn chiefly in the winter with no well defined beginning or end to the spawning season. Average-sized females lay over one million eggs. Cod are rarely found south of New Jersey. Young cod consume copepods whereas the most predominant item in the adult cod diet is the mollusc, especially sea clams, cockles and mussels. Cod also eat crabs, lobster and shrimp (TRIGOM, 1974). Table II-121 summarizes catch data.

Spot (Leiostomus xanthurus). Spot are abundant fishes in the estuarine and bay environments of the southern half of the middle Atlantic area.

Table II-120.

Fish Landings by State
FLOUNDER, YELLOW-TAILED
Limanda ferrigines
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	8925	747	4688	1090	--	--	--	15,450
	$ 1115	$ 93	$ 379	$ 73	$ --	$ --	$ --	$ 1,660
1971	11,810	474	7243	1297	--	--	--	20,824
	$ 1,499	$ 47	$ 449	$ 97	$ --	$ --	$ --	$ 2,092
1972	19,960	--	7189	867	--	--	24	28,040
	$ 2,891	$ --	$ 751	$ 90	$ --	$ --	$ 3	$ 3,735
1973	18,882	262	5034	1053	--	--	1	25,232
	$ 3,593	$ 40	$ 730	$ 122	$ --	$ --	$ 1	$ 4,486

Table II- 121.

Fish Landings by State
COD
Gadus morhua
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	3031	243	378	188	1	6	1	3848
	$ 331	$ 27	$ 56	$ 36	$ 1	$ 1	$ 1	$ 453
1971	2309	180	427	138	10	4	1	3069
	$ 296	$ 23	$ 71	$ 31	$ 2	$ 1	$ 1	$ 425
1972	2396	35	235	43	-	6	1	2716
	$ 461	$ 7	$ 36	$ 12	$ -	$ 1	$ 1	$ 518
1973	2976	106	332	85	-	2	1	3502
	$ 491	$ 18	$ 80	$ 26	$ -	$ 1	$ 1	$ 617

Their spawning season runs from January through April. Runs of mature adult spot appear, for example, in the Chesapeake Bay by early summer (Lippson, 1973), but the heaviest concentrations are found later in the season and into the fall months. Juvenile stages range further into low salinity ranges than do the adults. Table II-122 summarizes catch statistics.

Soft shelled clams (Mya arenaria). Soft shelled clams are widely distributed in bays and estuaries along the Mid-Atlantic coast, but commercial concentrations occur only in areas of moderate salinity. Populations of these clams can extend upriver to a salinity of about 5°/oo in sand or on sandy mud bottoms and generally in water less than 20 feet deep (Lippson, 1973). Table II-123 summarizes catch statistics.

White perch (Roccus americanus). White perch are semi-anadromous fish which are residents of estuaries especially the Chesapeake Bay where there are indigenous populations in many rivers (Lippson, 1973). In March, ripe individuals move upstream to nearly fresh water to spawn where their adhesive eggs attach onto branches and grasses. The perch remain until June. After hatching, the larvae remain in the area and the young white perch gradually move downstream into shallow beach zones to feed until winter. As winter approaches, the white perch move into depths greater than 30 to 40 feet and feed upon bottom fauna. Table II-124 summarizes catch statistics for this species.

Table II- 122.

Fish Landings by State

SPOT

Leiastomus xanthurus

(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	--	--	--	1	--	573	5873	6447
	$ --	$ --	$ --	$ 1	$ --	$ 80	$ 547	$ 628
1971	--	--	--	3	--	22	504	529
	$ --	$ --	$ --	$ 1	$ --	$ 4	$ 58	$ 63
1972	--	--	--	1	--	74	2951	3025
	$ --	$ --	$ --	$ 1	$ --	$ 12	$ 322	$ 334
1973	--	--	--	10	--	27	2576	2613
	$ --	$ --	$ --	$ 1	$ --	$ 5	$ 361	$ 367

Table II- 123.

Fish Landings by State
SOFT SHELLED CLAMS
Mya arenaria
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	87	--	73	70	--	6221	--	6451
	$ 57	$ --	$ 28	$ 36	$ --	$ 2434	$ --	$ 2555
1971	49	1	154	48	--	5986	--	6238
	$ 34	$ 1	$ 56	$ 28	$ --	$ 2993	$ --	$ 3112
1972	34	1	92	62	--	1949	--	2138
	$ 34	$ 1	$ 80	$ 50	$ --	$ 1015	$ --	$ 1180
1973	22	--	104	17	--	668	--	811
	$ 22	$ --	$ 115	$ 19	$ --	$ 557	$ --	$ 713

Table II- 124.

Fish Landings by State
WHITE PERCH
Roccus americanus
(Pounds and dollar value x 10^3)

	Rhode Island	Connecticut	New York	New Jersey	Delaware	Maryland	Virginia	Total
1970	42	7	166	77	16	1662	264	2234
	$ 8	$ 2	$ 31	$ 14	$ 3	$ 268	$ 35	$ 361
1971	39	23	107	87	18	1508	461	2243
	$ 8	$ 5	$ 16	$ 19	$ 3	$ 240	$ 63	$ 354
1972	21	59	55	106	18	1127	293	1679
	$ 6	$ 16	$ 14	$ 22	$ 4	$ 208	$ 40	$ 310
1973	21	68	103	142	23	763	251	1371
	$ 6	$ 20	$ 27	$ 32	$ 7	$ 163	$ 51	$ 306

Sport Fisheries

Marine sport fishing in coastal areas is participated in at significant levels throughout the Mid-Atlantic region. Table II-125 indicates the level of such activity for the years 1960, 1965, and 1970 by the number of salt-water sport fishermen, fish caught, and catch weight. Generally, the number of fishermen increased modestly in 1965 as compared with 1960, while at the same time the number of fish caught dropped by almost one-fifth. The results of the 1970 survey indicated that the number of fishermen was

Table II-125. Estimated Number of Salt-water Sport Fishermen and their Catches in the Mid-Atlantic Region,[1] 1960-1970

	1960	1965		1970	
	Number	Number	Percent[2] Change	Number	Percent[2] Change
Salt-Water Fishermen (Thousands)	1,344	1,375	2.3	1,767	28.5
Fish Caught (Thousands)	114,502	92,126	-19.5	168,209	82.5
Fish Caught (Thousands of Pounds)	178,000	128,288	-27.9	246,267	91.9

[1]New Jersey to Cape Hatteras, North Carolina.

[2]Percent change since previous survey.

(Source: National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 1973)

almost a third greater than in either 1960 or 1965, and the number of fish caught almost doubled from 1965. Recent trends indicate ever increasing numbers of sport fishermen.

Table II-126[1] displays data on the numbers of fishermen by State of residence and State fished for the five Mid-Atlantic States for the period June 1973 to June 1974. Of the more than 8 million persons that fished in the Mid-Atlantic States during that period 34 percent fished in New Jersey and 33 percent in New York.

On a numerical basis, New Jersey entertained the greatest number of nonresident fishermen with almost 1.3 million visitors (or 46 percent of its total). On a percentage basis, however, almost two-thirds of the people who fished in Delaware were nonresidents.

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[1]The 1974 survey produced estimates on the number of fishermen substantially higher than those resulting from the 1970 survey. The magnitude of difference can be attributed to the following factors:

- The 1970 Survey included persons 12 years of age and older, while the 1974 survey included all ages. According to the Bureau of Census, about 25 percent of the population in the area surveyed is 13 years of age and younger.
- The 1970 Survey included only those persons who had fished during parts of at least three days or spent at least $7.50 on the sport during 1970. The 1974 survey included all persons fishing at least once during the year.
- The 1970 Survey included only those persons engaged in finfishing while the 1974 survey included those who finfished and/or shellfished.
- Nearly four years elapsed between surveys during which time an increase in participation would be expected.

Table II-126. People Participating in Marine Sport Fishing in Mid-Atlantic States[1]

State of Residence	State Fished[2]				
	New York	New Jersey	Delaware	Maryland	Virginia
New York	2,290	300	22	40	86
New Jersey	162	1,463	33	43	51
Delaware	1	26	116	52	9
Maryland	12	61	90	750	112
Virginia	12	19	16	109	777
Other States[3]	157	238	41	233	2
Total	2,634	2,715	318	1,227	1,147

[1]Figures are in thousands of persons for the period June 1973-June 1974.

[2]State fished refers to state where shoreline fishing took place and/or state of launching for boat fishing.

[3]Includes Connecticut, District of Columbia, Maine, Massachusetts, New Hampshire, Pennsylvania, Rhode Island, Vermont and West Virginia.

(Source: National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 1975)

Table II-127 provides data on the principal areas and methods of fishing by numbers of fishermen,[1] fish caught, and weight of fish caught. Roughly the same number of fishermen fished the ocean as those who fished in sounds, rivers, and bays. More than twice as many fishermen fished from boats as opposed to fishing from shore. More than 80 percent of the fish caught, both in number and total weight, were taken by people fishing from boats. Almost 60 percent of the fish caught were landed in the sounds, rivers, and bays as opposed to the ocean. Consequently, it can be concluded that fishing from boats is both more popular and more successful than fishing from shore and that fishing in sounds, rivers, and bays is slightly more successful than ocean fishing.

Table II-128 ranks the top twenty[2] fish species by number of fish caught, their weight, and number of persons who fished for those species, for the Mid-Atlantic region in 1970. The statistics provide insight on the popularity and relative significance of individual species from a sport fisheries viewpoint. It should be remembered, however, that for some species that are generally regarded as "trash" fish (for example, puffers and searobins), the

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[1]It is assumed, for the remainder of this discussion, that the relative number of fishermen is a reflection of the popularity of species fished for as well as for areas fished and methods employed. This is based on the rationale that fishermen, with some obvious limitations, volitionally act to catch certain species based on the tackle, bait, and methods used as well as the areas fished.

[2]Twenty-three species are listed because in some instances a species would not rank in the top twenty in all three categories.

Table II-127. Salt Water Sport Fishermen and their Catches[1] by Principal Area and Method of Fishing for the Mid-Atlantic[2] Region in 1970

	Principal Area		Principal Method			
	Ocean	Sounds, Rivers and Bays	Private or Rented Boat	Party or Charter Boat	Bridge, Pier or Jetty	Beach or Bank
Salt-Water Fishermen (Thousands)	807	934	803	507	179	377
Fish Caught (Thousands)	69,541	98,668	91,830	45,009	7,822	23,548
Fish Caught (Thousands of Pounds)	128,189	118,078	123,678	87,304	10,303	24,982

[1]The number of fish caught and the weight of fish caught in the two principal areas of fishing are equal to the total catch, and the total number. However, the number of anglers is not additive as some anglers fished in both areas and by more than one method for certain species groups.

[2]New Jersey to Cape Hatteras, North Carolina.

(Source: National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 1973).

Table II-128. Relative Ranking of the Top Twenty Sport-fish Species by Numbers of Fish Caught, Weight, and Participating Fishermen[1] in the Mid-Atlantic Region[2]

	Number of Fish Caught		Weight of Fish Caught		Participating Fishermen	
	Number	Rank	Pounds	Rank	Number	Rank
Bass, striped	9,857	6	27,262	3	415	3
Bluefish	12,351	5	49,720	1	591	2
Catfishes	2,368	14	6,151	12	129	13
Croakers	4,617	10	3,831	15	175	12
Drum, black	26	-	1,454	20	3	-
Eel, American	367	-	740	-	38	20
Flounder, summer	4,191	11	7,742	9	339	8
Flounder, winter	7,496	8	12,881	7	402	4
Hake, red	497	19	904	-	36	-
Hake, silver	912	18	1,436	-	66	16
Kingfishes	1,911	15	2,402	17	183	11
Mackerel, Atlantic	18,441	3	29,250	2	126	14
Perch, white	15,072	4	12,592	8	363	7
Perch, yellow	3,324	13	2,581	16	53	18
Porgies	1,188	17	2,127	18	117	15
Puffers	27,608	2	16,568	5	653	1
Seabass, black	3,844	12	6,710	11	206	10
Searobins	5,831	9	6,741	10	367	6
Shad, America	1,541	16	4,231	13	52	19
Spot	32,952	1	21,573	4	374	5
Tautog	383	20	1,619	19	61	17
Wahoo	172	-	3,985	14	8	-
Weakfish	9,397	7	14,039	6	325	9

[1]All numbers are in thousands except rankings.

[2]New Jersey to Cape Hatteras, North Carolina.

(Source: 1970 Salt Water Angling Survey, National Marine Fisheries Service, National Oceanic and Atmospheric Administration).

data is merely an indication of success and does not reflect intent on the part of the fishermen.

Bluefish, puffers, spot, and striped bass rank within the top third for all three categories. Atlantic mackerel and white perch, along with the four species mentioned above, had annual catches at or exceeding 10 million fish. Those six species, along with winter flounder and weakfish, had annual 1970 catches in excess of 10 million pounds each. Only puffers and bluefish had more than half a million persons who successfully landed them. The following species, however, had at least one-third of a million persons who successfully landed them: summer flounder; winter flounder; white perch; searobins; spot and striped bass.

The above discussion provides a general overview of marine sport-fishing activity in the Mid-Atlantic region. The following discussion will provide more detailed information on such activity for specific stretches of coastal waters in the region. The many varieties of fishes inhabiting the waters around eastern Long Island and this area's accessibility to a large population make it extremely popular for sport fishing. Bluefish, summer flounder, black seabass, porgies, striped bass, and weakfish combined make up about one-third of total angler's catch, with porgies being the most frequently caught species. Bluefish migrate to the eastern end of Long Island each year, and this seems to be one of the few areas

alon, the east coast where exceptionally large bluefish occur within casting distance of shore. Striped bass, more coastal in habit than bluefish, are also abundant in this area, especially near Montauk Point. The numbers of weakfish caught in this area have declined greatly since the 1930's when they were the most abundantly caught species. There is hope, however, based on increased catches in the late 60's and early 70's, that weakfish may be returning to their former abundance. Black seabass and summer flounder, once caught in great numbers, have declined as severely as the weakfish.

Of the many kinds of fishes inhabiting Great South Bay and the coastal waters adjacent to Fire Island, winter flounder and summer flounder are the most important to sport fishermen. During some seasons within the last 15 years, these two species comprised over three-fourths of the gamefish landed. The abundance of winter flounder has remained about the same for the last 35 years. The catch of summer flounder used to about equal that of winter flounder at a level of 1.5 million annually, but the catch of summer flounder has dropped dramatically during the last 15 years to less than 10 percent of its previous level. The various fishing grounds adjacent to the New York metropolitan area, in New York Bay and along the western and northern shores of Long Island and New Jersey respectively, are among the most intensively fished in the world.

A wide variety of species are fished for and landed throughout the area. The fish, while tending to be somewhat ubiquitous, do tend to concentrate in some areas more consistently than others. Some of these areas are characterized by outcrops of rocks and large boulders which interrupt the otherwise smooth sandy bottom. Dumping grounds for excavated material, building rubble and garbage, along with the numerous shipwrecks that have occurred over the course of many years, also provide suitable concentration points for fish. In some instances efforts have been undertaken to intentionally establish artificial reefs. Some of these reefs are depicted on Visual 1. Although a number of species are caught in the area in significant numbers annually, bluefish and striped bass remain among the more popular.

Striped bass and white perch are prevalant in abundant numbers along the Atlantic Coast of New Jersey, especially in Barnegat Bay. Puffers, kingfish, and summer flounder, in addition to striped bass and white perch, occur in the estuaries during the warm months. Along the beaches, as in most of the Mid-Atlantic States, scup, summer flounder, sea bass, tautog, and bluefish are among the more frequently caught. During the colder months these species are replaced by Atlantic mackerel, cod, and the hakes. Generally, the bottom along this part of the Continental Shelf is virtually a level sandy plateau interrupted by scattered shoals.

This series of gullies and sand mounds, some of which rise to within 17 feet of the surface, provides for excellent fishing grounds. Five Fathom Bank, the most famous and extensive of these shoals, lies within 10 nautical miles off the coast of the Wildwoods in southern New Jersey.

About 150 kinds of fishes inhabit Delaware Bay and Chesapeake Bay during part or all of their lives. Weakfish, kingfish, summer flounder, porgies, striped bass, white perch, and bluefish are among those more frequently fished for and caught. Among these the weakfish are the particular favorite. These same species are popular sport fishes along the remainder of the Atlantic coasts of Delaware, Maryland, and Virginia from Cape Henlopen to Cape Charles.

Big-game sport fishing is also becoming increasingly popular in the Mid-Atlantic area. White and blue marlin, broadbill swordfish, and mako sharks are some of the larger species which are sought. Charter and private sport-fishing boat trips from such ocean shore towns as Atlantic City, Ocean City, Cape May, and Brielle, New Jersey; Ocean City, Maryland; Virginia Beach and Hampton Roads area, Virginia, run 40 to 100 miles offshore from east of Hudson Canyon to and beyond the Baltimore Canyon in the Mid-Atlantic OCS.

g. Military Uses of the Environment

A large portion of the Mid-Atlantic Continental Shelf and the adjacent shoreline is presently being used for various military purposes. Figure II-80, following, depicts the locations and general activities known to be carried out on or over the OCS. These include, but are not limited to, submarine operations, air exercises, gunnery practice, and missile and rocket testing. The majority normally takes place in areas specifically designated for such purposes and are under the control of either the Army Corps of Engineers, the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), or the U. S. Coast Guard (USCG).

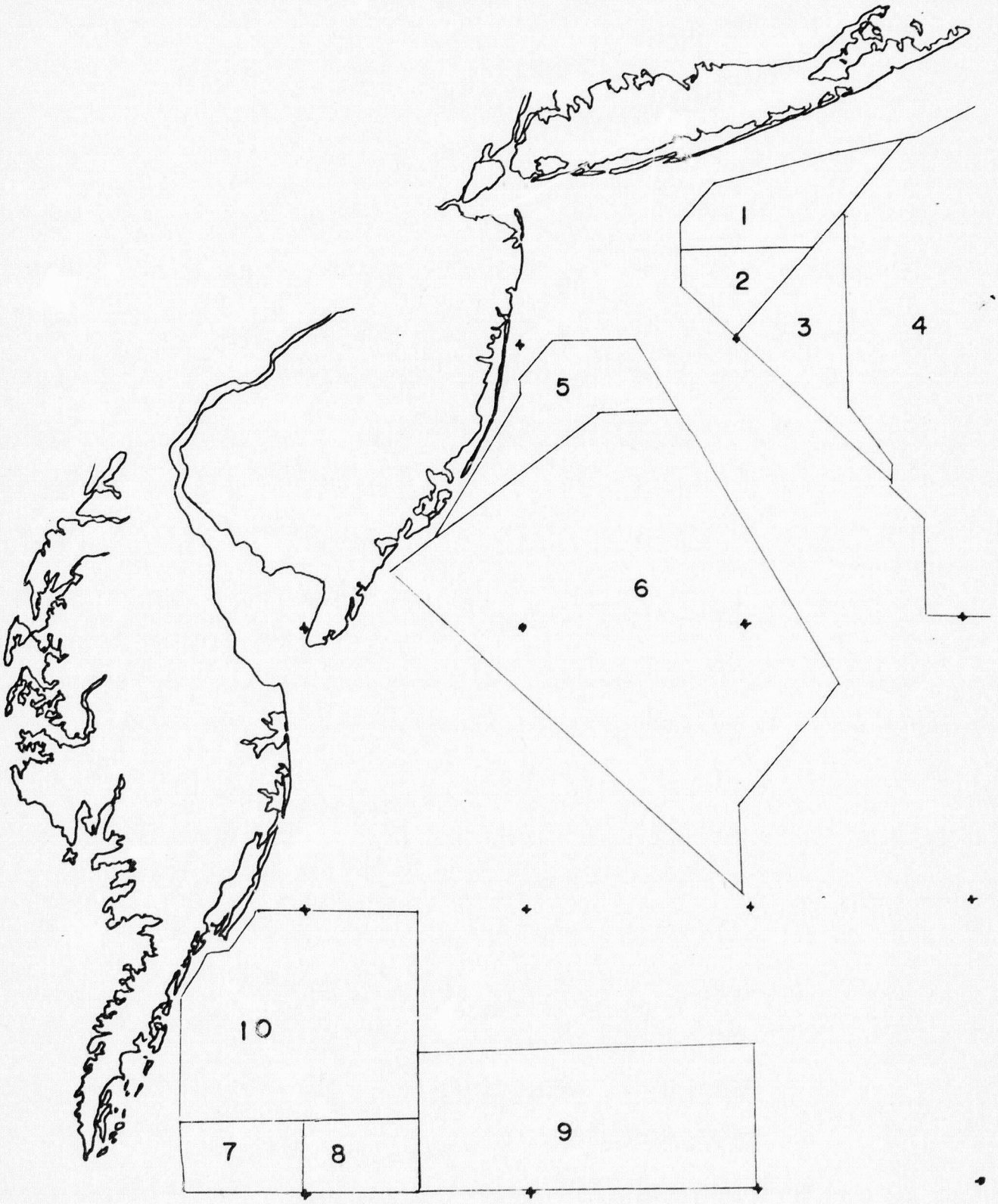

Figure II-80. Military Uses of Mid-Atlantic Outer Continental Shelf
(Legend on following page.)

Figure II- 80. Military Uses of Mid-Atlantic Outer Continental Shelf

1 - Anti-submarine warfare tactics

2 - Surface gunnery and anti-submarine warfare (except 15 May to 15 September)

3 - Anti-submarine warfare tactics and air gunnery exercises

4 - Submarine training and anti-submarine warfare tactics

5 - Navy helicopter sonar dipping, Air Force and Air National Guard gunnery exercises (surface gunnery prohibited during 15 May to 15 September). Defense warning area.

6 - Navy anti-submarine warfare tactics, Air Force and Air National Guard gunnery exercises. Defense warning area.

7 - Surface gunnery exercises serviced by tug and sled

8 - Ship anti-aircraft firing services by aircraft towed target

9 - Various activities including surface and air firing events and submarine operations

10 - Rocket launch safety zone, Wallops Island facility (NASA).

Information provided in Atlantic Fleet Operating Areas within the Eastern Sea Frontier (U.S. Navy, 1972).

Naval operations, which are the most likely to be affected by offshore drilling, are controlled by the Naval Submarine Base at Groton, Connecticut; the Naval Air Station at Lakehurst, New Jersey; and the Naval Air Station Oceana at Virginia Beach, Virginia. These bases fall under the jurisdiction of the Commander, Eastern Sea Frontier (Brooklyn, New York). Naval and other military air operations are coordinated with the Federal Aviation Agency. Rocket firing events (mostly meterological experiments) take place at the NASA facility at Wallops Island, Virginia. Various activities of a classified nature, under the control of the DOD are conducted in the Mid-Atlantic region.

Detailed information regarding most of these activities and the related areas can be found in United States Coast Pilot 2, United States Coast Pilot 3, Atlantic Fleet Operating Areas within the Eastern Sea Frontier, and various nautical charts published by the National Ocean Survey. These nautical charts are especially useful in locating areas of jettisoned explosives. For example, in the Mid-Atlantic Region, there are eighteen sites (excluding dump sites) where jettisoned explosives are believed to be located. (Visual 1 depicts those sites which are located within the general area of the proposed leasing action.)

In addition, Local Notices to Mariners and Notices to Mariners are issued on a weekly basis by the local Coast Guard District Commander and the Defense Mapping Agency respectively. The purpose of these notices is to advise vessel operators of any recent marine information which may affect the safety of navigation. Marine information of a more immediate nature, however, is broadcast over various radio frequencies by the USCG as Marine Broadcast Notices to Mariners.

An overview of military uses along the entire Atlantic Coast may be found in the Final EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol. 1, P. 460.

h. Archeologic and Historic Resources[1]

Archeologic Resources

Man's occupation of the Atlantic coastal region dates back over 12,000 Before Present (BP) years and perhaps as much as 40,000 years BP[2]. These early Americans, known as Paleo-Indians, were primarily hunter/gatherers and the evidences of their presence

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[1]The Final EIS on the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol.1, P. 472, presents an overview of these resources for the entire Atlantic Coast.

[2]A data of 40,000 years was obtained from analysis of peat samples associated with human artifacts at the Holly Oak site in Delaware. Some uncertainty exists as to whether this older peat layer or a more recent one (2000 years BP) reflects the true age of the artifacts (Thomas, 1974).

are usually fluted spear heads (clovis points) and animal remains. From the distribution of spear point finds, it is most likely that Paleo-Indians migrated along major river systems, such as the Allegheny, Susquehanna, and Delaware (Nassau County Museum, 1971) and ranged through both coastal and inland areas of all the Mid-Atlantic states (Nassau County Museum, 1971; Cross, 1970; Thomas, 1974).

Remains of mastodons and shallow water shellfish which could have provided food for early man have been recovered well out on the OCS (Section II.A.3). Although no implements of Paleo-Indians have been found offshore, it is probable that they lived on the Continental Shelf exposed by sea level retreat. As sea level rose at the end of the Pleistocene, any meager shelters that they built would have been destroyed, but their tools might remain in marine sediments (Emery and Edwards, 1966).

The next stage of Indian cultural development which is recognized in the Mid-Atlantic is the Archaic. Changing climatic conditions (more temperate) and extinction of many large game animals either caused the Paleo-Indian to change living styles or, as Thomas (1974) suggests, migrate out of the area probably around 8000 years BP. The Archaic Indians were adapted to both forest and coastal living and were somewhat nomadic (Salwen, 1965; Cross, 1970). Artifacts

located in the region include larger spear points, spear throwers, javelins, and implements for fishing, cooking, woodworking, and sewing. Late Archaic sites include remnants of stone bowls carved out of steatite (soapstone), implements for making canoes, and cremation cemetaries (such as the Koen's Crispin complex in New Jersey).

Sea level had still not returned to present levels when the Archaic Indians lived in the region (8000 to 3000 BP) and evidence indicates that this group also occupied sites on the OCS.[1] Some controversy exists over whether or not they ate marine shellfish since only the more recent Archaic sites on land contain these remains. However, Emery and Edwards (1966) and Salwen (1965) point out that kitchen middens would be located quite close to the shoreline so these sites would long since have been inundated. Many sites on Long Island, Connecticut, and Massachusetts have been located nearshore, and even within present tidal extremes.[2] Artifacts of Archaic Indians found offshore would probably include fire-cracked rocks, projectile points, and other stone tools.

Transitional Stage people incorporated traditions of the Archaic Indians (hunting/gathering) and also used baked clay pottery, bows and arrows, and rudimentary agriculture, dominant characteristics

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[1]See Bibliography.

[2]R. J. Wyatt, Nassau County Museum, Glen Cove, New York, written communication, 1975.

of the later Woodland Indians. The Transitional Stage lasted from perhaps 3000 to 2500 BP (Cross, 1970).

With these new cultural advances, camp sites became larger and amounts of artifacts at individual sites increased. Burial sites and rituals were fairly complex and shell middens extensive. During this stage and that of successive Woodland Indians, sea level had reached close to its present height; thus, any occupation sites were located near to the modern shoreline or have only relatively recently been inundated.

The Woodland period lasted from about 2500 BP to the time of contact with European settlers. The shift to a mostly agricultural economy in fixed camps is the most significant feature of these Indians. Figure II- 81below shows the tribal distributions in the region at the time of European contact.

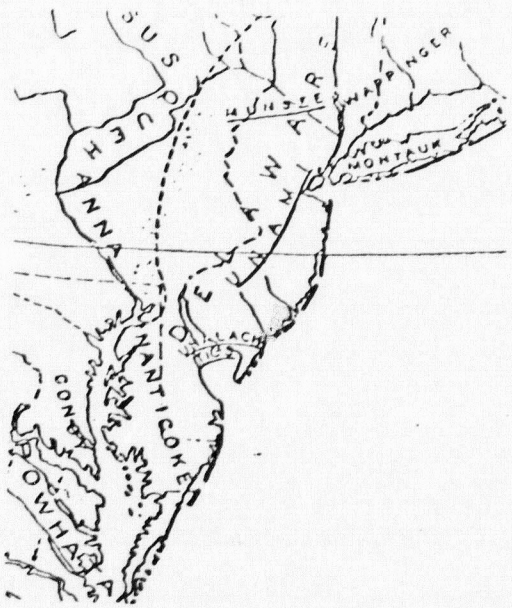

Figure II-81.
(From Sivanton, 1952)

Historic Resources

The coastal areas in the Mid-Atlantic States have played a prominant part in American history from earliest colonial times. The Ports of New York and Philadelphia were not only important settlements during colonial times but also served as major entry points for the numerous immigrant groups which have enriched America's heritage. A significant number of designated historic sites dating from the 18th and 19th centuries exist in the region, as has been confirmed by State Historic Preservation Officers in the Mid-Atlantic area. Almost all of these sites, however, are inland from the actual coastline. Consequently, they are not discussed here. The following list contains sites listed on the National Register of Historic Places[1] and those that have been identified as being eligible for inclusion on the Register. They are coastally oriented and, consequently, could be affected by OCS-associated development in the event this proposed sale is held. The following is a listing of those sites (the sites eligible for Register inclusion are identified by an asterisk):

NEW YORK

New Dorp Light (Suffolk County)

*Fire Island Light Station (Suffolk County)

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[1] As of April 6, 1976.

NEW JERSEY

Absecon Lighthouse (Atlantic County)

Cape May Lighthouse (Cape May County)

Cape May Historic District (Cape May County)

Cape May is one of the oldest seashore resorts in America. As early as the 1660's, an economy based on fishing and farming was developed. Cape May began to flourish as a resort after the War of 1812. Today, six-hundred 19th and early 20th century structures--hotels, churches, private homes, and commercial buildings--of outstanding architectural quality make Cape May a showcase of late Victorian architecture.

Twin Lights-Navesink Lighthouse (Monmouth County)

The Reservation (Monmouth County)

Sandy Hook Light (Monmouth County)

Barnegat Lighthouse (Ocean County)

DELAWARE

Fort Delaware (New Castle County)

Fort Delaware is located on Pea Patch Island in the Delaware Bay adjacent to Delaware City. An earthwork structure was built there in 1813 followed by a masonry structure in 1821. The latter was destroyed by fire and the existing fort was completed in 1859. The fort has pentagonal walls of granite blocks measuring 7 to 30

feet in width and 32 feet in height with the entire fortification occupying almost six acres. Confederate prisoners of war were incarcerated there from 1862 to 1865, and troops were stationed there during both the Spanish-American and First World Wars.

Augustine Beach Hotel (New Castle County)

Eastern Lock of the Chesapeake and Delaware Canal (New Castle County)

Fishers Paradise (Sussex County)

De Vries Palisade (Sussex County)

*Delaware Breakwater (Sussex County)

*Harbor of Refuge Breakwater (Sussex County)

MARYLAND

Thomas Point Shoals Light Station (Anne Arundel County)

*Bloody Point Bar Light (Anne Arundel County)

*Sandy Point Shoal Light House (Anne Arundel County)

Fort McHenry National Monument and Historic Shrine (Baltimore City)

*Craghill Channel Upper Range Front Light (Baltimore County)

Cove Point Lighthouse (Calvert County)

Drum Point Lighthouse (Calvert County)

Old Lock Pump House (Cecil County)

*Turkey Point Light (Cecil County)

*Havre De Grace Light (Harford County)

*Piney Point Light Station (St. Mary's County)

*Point No Point Light (St. Mary's County)

*Sharp's Island Light (Talbot County)

Sandy Point Site (Worchester County)

VIRGINIA

Assateague Island Lighthouse (Accomack County)

New Point Comfort Lighthouse (Mathews County)

Sites listed above include those in the actual shoreline zone which may have a potential for being impacted by offshore oil and gas development and directly related OCS coastal facilities. The State of Delaware, through the State Historic Preservation Officer, has expressed concern over other National Register sites: Maull House in Sussex County and Island Fields Site in Kent County, which are in close proximity to the coast, as well as sites further inland, including the Liston House and Hart House in New Castle County and the John Dickinson House and Town Point in Kent County.

Significant amounts of shipping traffic traversed the coastal waters adjacent to the Mid-Atlantic States in previous centuries as it continues to do today. A number of shipwrecks have occurred over the years which may have historical significance. Some shipwreck locations are noted on nautical charts, while others remain as yet undetected. The historical significance of these, as well as many of the known

wrecks, remains to be determined by recovery efforts. It is anticipated that at some time in the future the National Park Service will undertake a wreck inventory effort similar to that which was done for the Gulf of Mexico. Geophysical studies to be conducted before drilling begins (in the event that this sale is held) may locate possible shipwreck sites. Any such suspected remains will be avoided in the positioning of drilling rigs or platforms.

i. Ocean Dumping

In the Mid-Atlantic region there are few remaining areas in which ocean dumping still occurs.[1] In the New York Bight, there are six sites which service the New York-New Jersey metropolitan area, and in the area near Cape May there are two sites which service the Philadelphia, Pennsylvania-Camden, New Jersey, area and the DuPont facilities at Edge Moor, Delaware. Locations are shown in Figures II-82, II-83, and II-84. In accordance with the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 (PL92-532) permits are required for ocean dumping and are administered and approved by the EPA or the Corps of Engineers. The Corps issues permits for disposal of dredged materials, while EPA issues permits for all other wastes disposed of in the ocean. Prior to the effective date of MPRSA in April 1973, the Corps administered all ocean dumping. Many permits have not been renewed recently in view of the fact that as recommended by MPRSA, ocean dumping is to be minimized as a disposal method.

New York Bight

The major dump sites in the New York Bight have been set aside for the following six types of wastes: sewage sludge, dredged material, cellar/rubble dirt, acid wastes, chemical wastes, and wrecks derelict/vessels (Figures II-82 and II-83).

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[1] See Visual 1.

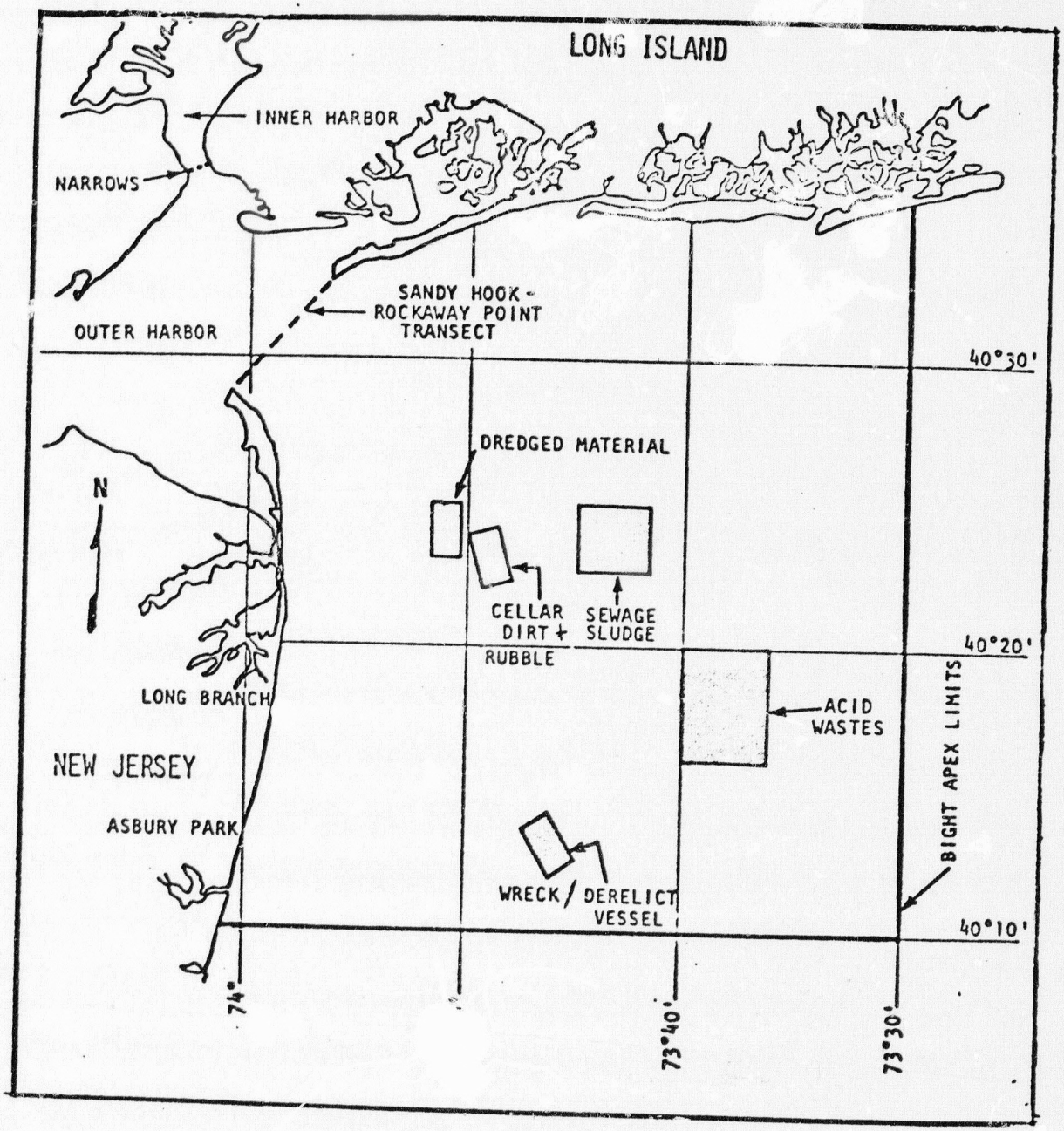
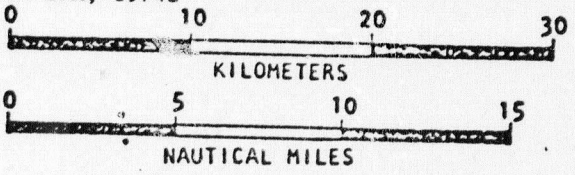


Figure II-82. Existing Dumpsites in the New York Bight Apex
Adapted from EPA, 1974e



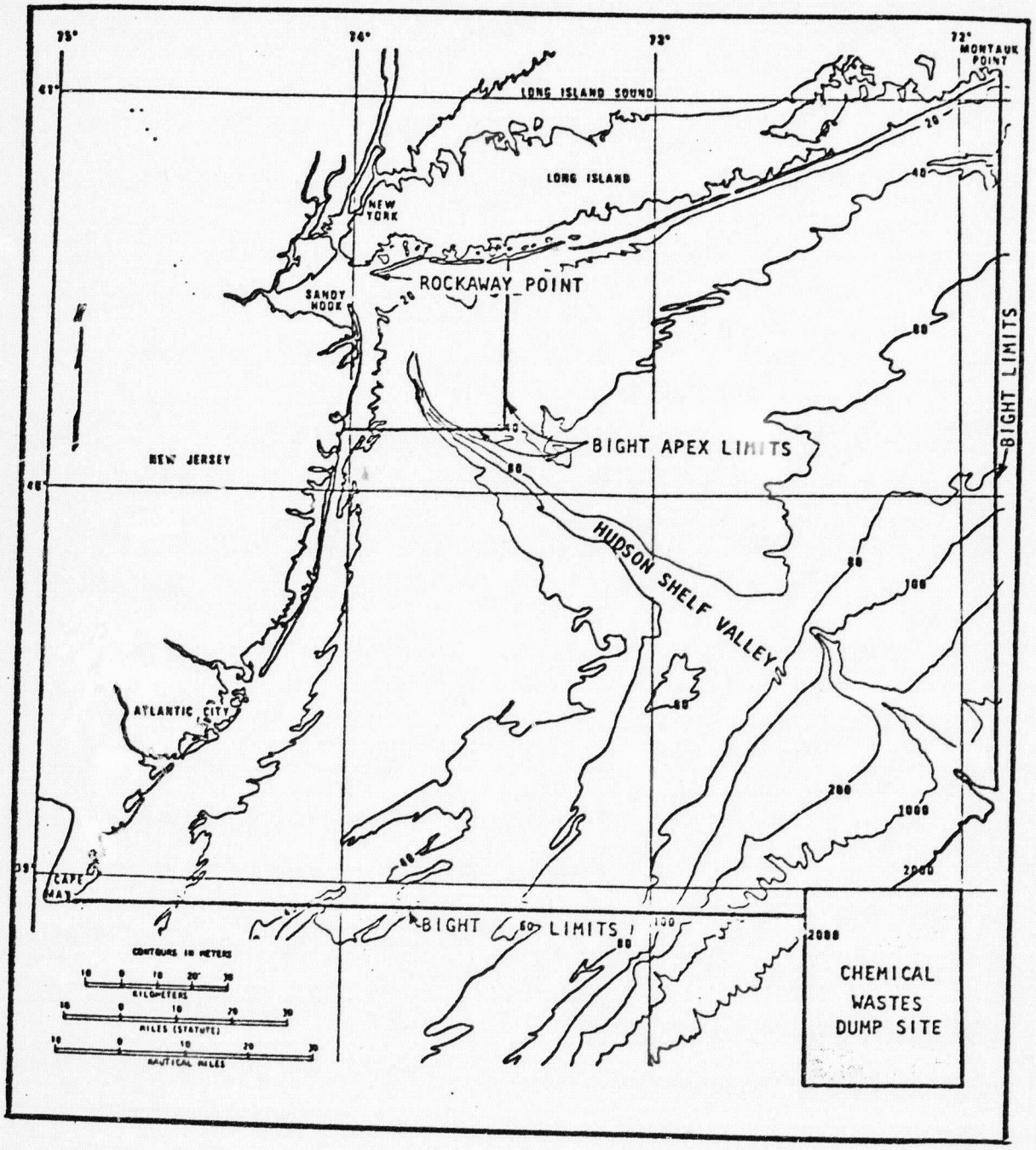


Figure II- 83. Chemical Waste Dumpsite
Adapted from EPA, 1974e

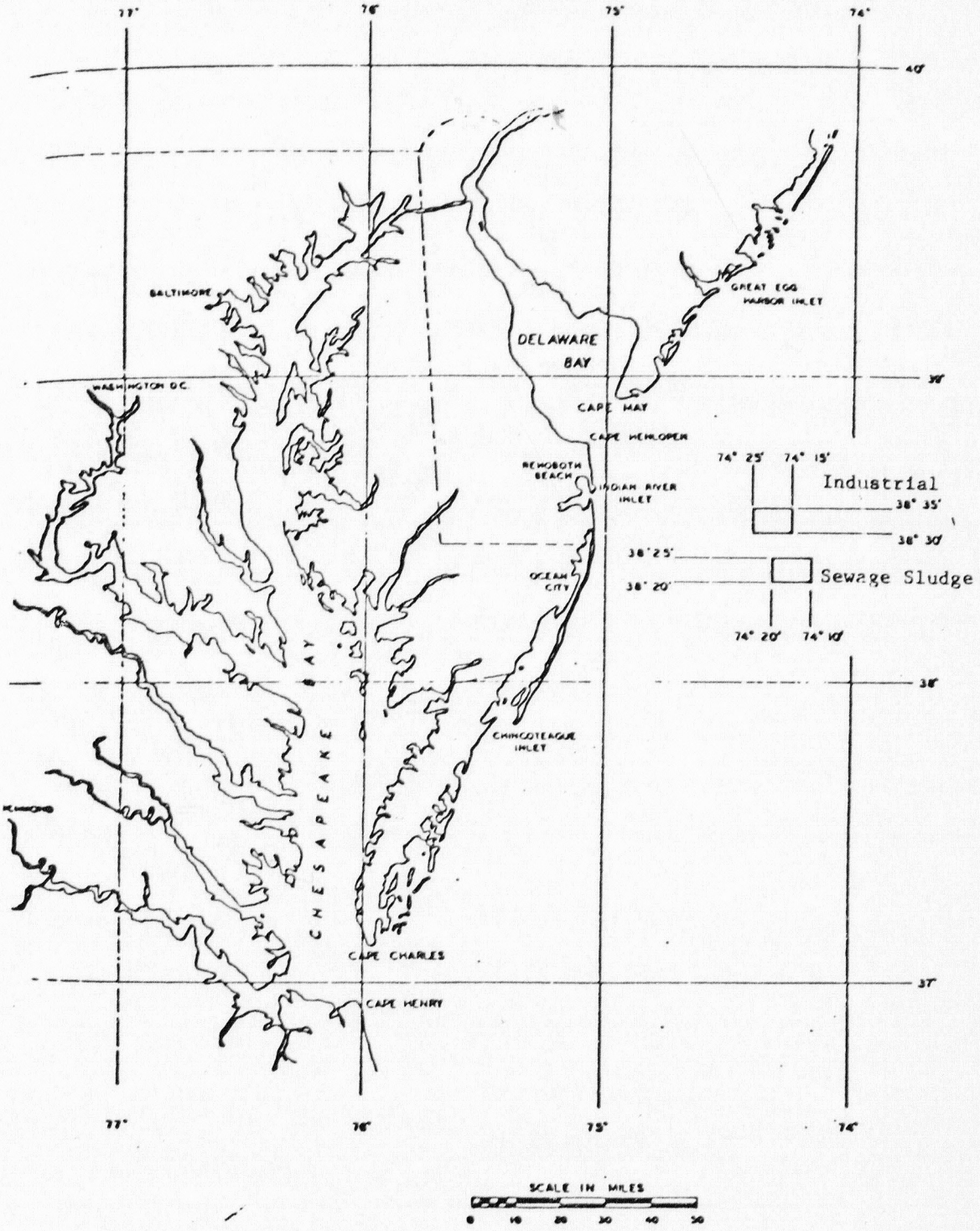


Figure II-84 . Ocean Dumpsites Off Cape May, New Jersey
(From Lear and Pesch, 1975)

Table II-129 . OCEAN DUMPING SITES IN THE NEW YORK BIGHT
(Supporting data for Figures II- 82 and II- 83)

Type Waste	Location Latitude Longitude	Area Sq Kilimeters (Sq N Miles)	Depth Meters (Feet)
Sewage Sludge	40°22'30"N to 40°25'00"N 73°41'30"W to 73°45'00"W	22.7(6.6)	27 (90)
Dredged Material	40°24'10"N 73°51'00"W[1]	6.9(2.0)	27 (90)
Cellar Dirt	40°23'00"N 73°49'00"W[1]	6.9(2.0)	31 (103)
Acid Wastes	40°16'00"N to 40°20'00"N 73°36'00"W to 73°40'00"W	41.0(12.0)	24 (80)
Wrecks	40°13'00"N, 73°46'00"W[1]	6.9(2.0)	60 (200)
Chemical Wastes	38°40'00"N to 39°00'00"N 72°00'00"W to 72°30'00"W	1,550.0(450.0)	1,800.0 (6000)

[1]EPA, Region II

Table II-130. OCEAN DUMPING SITES OFF CAPE MAY, NEW JERSEY[1]
(Supporting data for Figure II- 84)

Type Waste	Location Latitude	Longitude
Sewage Sludge Treatment	38° 20'- 38°25'	74° 10'-74°20'
Chemical Wastes	38° 30'- 38°35'	74° 15'-74°25'

[1]From Mueller and Jeris (]975)

Sewage Sludge

Sludge is the semi-liquid (approximately four to five percent solids) product which results from municipal and domestic wastewater treatment. The present site, selected in 1924, is currently used for the dumping of sewage sludges from primary, secondary, and tertiary municipal treatment facilities. Prior to 1974, some industrial wastes and garbage were also dumped at this site. Nearly 80 percent of the sludge (500 dry tons/day) produced in the New York-New Jersey metropolitan are is transported to this site (ISC, 1975), the remainder being disposed of primarily by incineration and landfilling. EPA has prepared a draft environmental impact statement on relocating this site to a site approximately 65 miles from the harbor entrance. This action is in expectation of an increase to 2000 dry tons/day or 60,000 cubic yards of sludge over the next five years due to the upgrading of wastewater treatment facilities (ISC, 1975),and the potential adverse impact of this increased dumping on recreational waters. As of July 1975, 22 municipal wastewater treatment authorities and three commercial haulers in the New York-New Jersey metropolitan area had EPA permits to dump their sewage sludge at this site (Table II-131). Three other permits have been issued by EPA for the disposal of sludges resulting from biologically treated industrial wastes. Figure II-85 and Table II-132 show the volume of sludge dumped at the site since 1960.

Table II-131.- VOLUMES OF SEWAGE SLUDGE DUMPED IN THE NEW YORK BIGHT[1]
(1973 and 1975)

1975 Permit Number[1]	Permittee	Sewage Sludge in Thousands of Cubic Meters (Cubic Yards) 1973		1974	
NJ002	Middletown Sewerage Authority	17	(22)	10	(13)
NJ003	Passaic Valley Sewerage Co-missioners	537	(702)	573	(750)
NY007	City of Long Beach	18	(24)	18	(24)
NJ008	Middlesex County Sewerage Authority	307	(402)	321	(427)
NY009	City of New York	2,471	(3,231)	1,815	(2,372)
	Bowery Bay	343	(448)	172	(225)
	Coney Island	112	(146)	86	(113)
	Hunts Point	218	(285)	83	(108)
	Jamaica	168	(219)	130	(170)
	Owls HEad	179	(234)	76	(99)
	Newtown Creek	888	(1,162)	744	(973)
	Port Richmond	21	(28)	25	(32)
	Rockaway	27	(35)	45	(59)
	Tallman Island	65	(85)	18	(23)
	Wards Island	391	(512)	372	(487)
	26th Ward	59	(77)	64	(83)
NJ017	Modern Transportation Co.	236	(308)	293	(383)
NJ019	Bergen County Sewerage Authority	218	(285)	181	(237)
NJ021	Linden Roselle Sewerage Authority	48	(63)	63	(82)
NJ022	Joint Meeting of Essex & Union Counties	93	(121)	106	(138)
NY028	Nassau County	224	(293)	225	(295)
NY029	Westchester County	77	(100)	77	(100)
NY031	West Long Beach Sewer District	3	(4)	3	(4)
NJ063	Whippany Paper Board[2]	-	-	-	-
NJ068	City of Glen Cove	NA	(NA)	NA	(NA)
NJ103	Caldwell Trucking Co.[3]	-	-	-	-
NJ106	American Cyanamid[2]	-	-	-	-
NJ109	S.B. Thomas[3]	-	-	-	-
NJ111	General Marine Transportation Corp.	28	(37)	31	(41)
	TOTALS	4,277	(5,592)	3,722	(4,866)

NA = Not Available.
[1]EPA-Region II permit number
[2]Included with NJ017.
[3]Included with NJ111

Adapted from EPA,1976

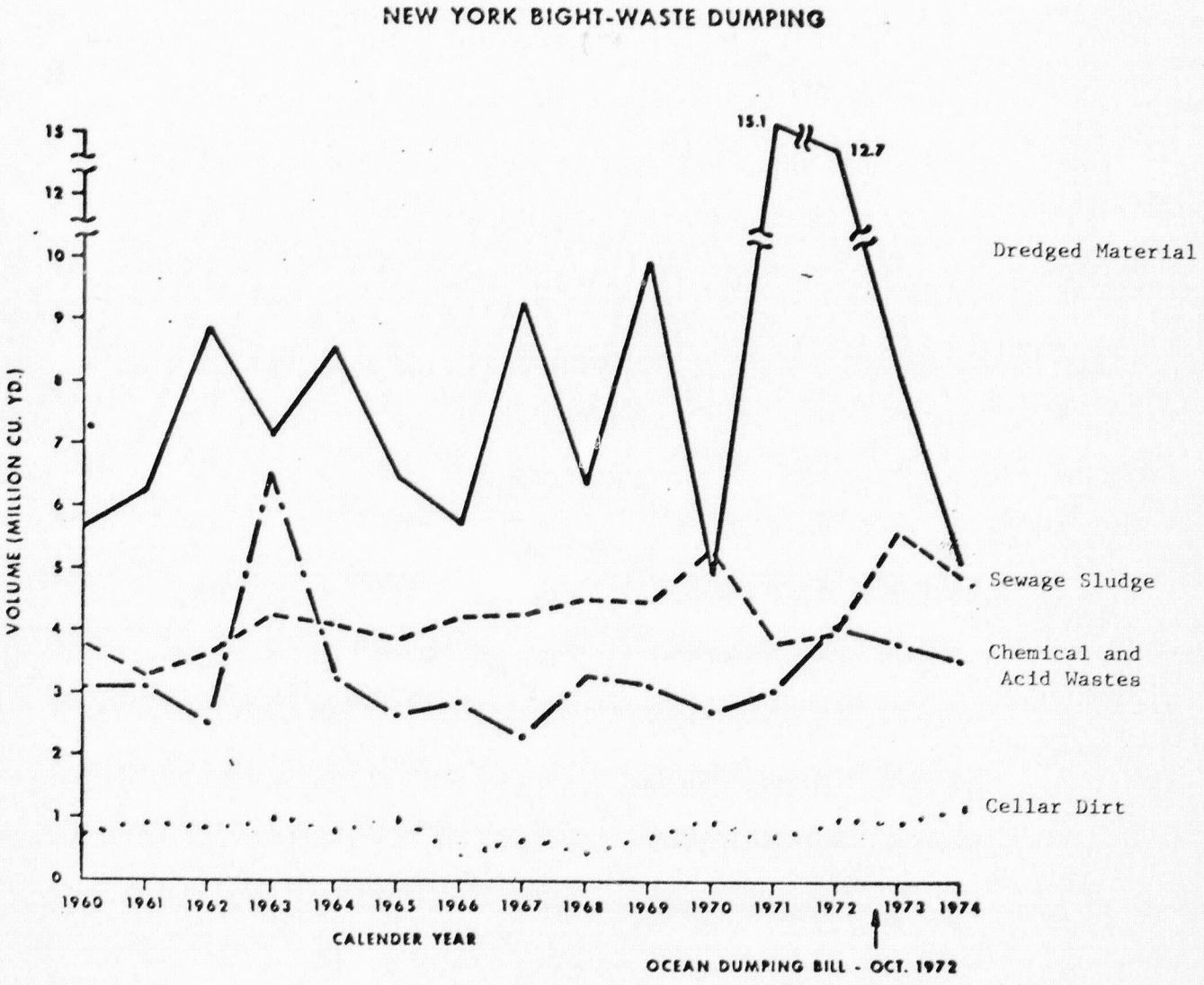


Figure II-85. Volumes of Wastes Dumped from 1960 to 1974. (Adapted from EPA, 1975a)

Table II-132. -VOLUMES OF WASTE MATERIALS DUMPED INTO THE NEW YORK BIGHT
(Supporting data for Figure II-85.)

(Cubic Yards)

	1960	1961	1962	1963	1964	1965	1966	1976
Dredged Material	5,611,174	6,238,00	8,816,000	7,186,000	8,540,000	6,480,000	5,687,000	9,214,000
Sewage Sludge	3,819,855	3,354,000	3,626,000	4,259,00	4,078,000	3,863,000	4,201,000	4,265,000
Chemical Wastes	-	7,000	13,000	690,000	-	-	-	150
Acid Wastes	3,071,000	3,100,000	2,551,000	5,797,000	3,310,000	2,634,000	2,857,000	2,297,000
ellar Dirt	738,000	810,000	807,000	988,000	756,000	912,000	319,000	509,000

	1968	1969	1970	1971	1972	1973	1974
Dredged Material	6,361,000	9,880,000	4,905,000	15,062,000	12,785,000	8,130,000	5,113,000
Sewage Sludge	4,481,000	4,455,000	5,287,000	3,830,000	3,955,000	5,600,000	4,860,000
Chemical Wastes	83,000	86,000	160,000	222,000	943,000	664,000	585,000
Acid Wastes	3,143,000	3,054,000	2,605,000	2,828,000	3,112,000	3,136,000	2,970,000
Cellar Dirt	400,000	632,000	796,000	676,000	969,000	827,000	1,048,000

Adapted from EPA, 1975a.

Besides those compounds normally present in human waste, these sludges contain compounds from industrial discharges and those carried by rainwater runoff into the collection systems. These include oils, greases, detergents, animal wastes, and significant quantities of trace metals.

Dredged Material

Material dumped at this site includes that dredged from vessel berths, harbors, channels, and anchorage grounds. Prior to 1974, some clean earth and fly ash from fossil-fueled electrical generating plants were dumped at this site, but this is no longer allowed. The present site was chosen in 1940 when the original site designated in 1888, had to be abandoned; the shoal created by the dumped dredged material had become too high.

Dredged material represents the largest volume of waste disposed of in any ocean dump site. Figure II- 85 shows the volumes dumped since 1960. The volume varies noticeably because it is dependent on economic development. The expansion of harbor facilities, use of deep draft vessels, or reduction in construction exert significant effects on the volume.

Dredged material contains natural organic matter from drainage basins and organics from both raw and untreated sewage that have been discharged into the receiving waters. It also contains significant amounts of trace metals, especially lead and chromium (MESA, 1975; Mueller and Jeris, 1975).

Cellar Dirt/Rubble

This is used to dump material resulting from building, demolition work, tunnel blasting, highway construction, and so on. Most of it comes from the Manhattan area since so little land is available for landfill there. Figure II-85 shows the volume of fubble disposed of at the site since 1960. The variability in supply indicates that this too is dependent on economic development and the use of rubble for shoreline fill.

Acid Wastes

This site has been used since 1948, primarily by two New Jersey industries, and the annual volume has been relatively constant since 1960 except for 1963 (Figure II- 85 and Table II- 132). By-product hydrochloric acid, spent sulfuric acid solution, and an inert ore slurry are the principal types of wastes dumped here.

Chemical Wastes

The present site, 106 miles from the harbor entrance, has been in use since 1964; the previous site was located 15 miles from shore. The high cost of transportation prohibits extensive use of the site. At present, 18 industries are permitted by EPA to dump waste here, though many of these plan to phase out this practice. In fact, under the implementation schedules set up by EPA permit conditions, only four will continue dumping at this site after 1978, and these four will also phase out their operations by 1981.

The waste represents those materials refused for disposal in landfills or streams for fear of contaminating water supplies. Table II-115 shows waste volumes since 1961.

Wrecks/Derelict Vessels

EPA is responsible for issuing permits for the disposal of sunken or abandoned vessels. However, because of objections by the U.S. Coast Guard that these are potential navigational hazards, no such permits have been issued since 1973. In all, only nine vessels have been disposed of at the site during the last 20 years. Much of the wooden material, bulkheads, drift boats, and so on that is collected is incinerated at the Caven Point smokeless incinerator in Jersey City, New Jersey.

Ocean Dumping Sites Off Cape May, New Jersey

The remaining ocean dumping sites are used by the Philadelphia, Pennsylvania and Camden, New Jersey metropolitan areas for disposal of their sewage sludge and by Dupont for disposal of titanium dioxide processing wastes. These are to be phased out by 1981, 1979, and 1978,respectively. Table II- 133 indicates the disposal volumes allowed by EPA permit for 1974 and 1975.

Table II- 133. Permits for Sludge Dumped off Cape May[1] 1974-1975

Source	Type	1974 Permitted Volume (gallons)
Camden, New Jersey	Partially Digested sewage sludge	15,000,000
Philadelphia, Pennsylvania	Digested Sewage sludge	150,000,000
DuPont	Titanium dioxide processing wastes (and Wastes)	125,000,000

[1] From EPA, 1975b

j. Solid Waste

Solid waste management is considered a state and local problem. The Federal government has no jurisdiction over disposal practices at other than Federal installations. It does provide grants for research and the development of new methods of collection and disposal and purchases recycled materials. It has, in the past, funded demonstration projects for new technologies and has tried to eliminate discriminatory interstate transportation rates.

Most states require regional or county management plans specifying conditions and future alternatives. Regions and counties are urged to cooperate so as to share the financial burden and maximize the use and efficiency of disposal facilities. The problems are most acute in population centers where density is high, waste volumes are large, and disposal sites are scarce.

Estimates of the amount of solid waste generated per person range from 3.3lb/day to 6lb/day (Snyder, 1974; CEQ, 1974). The 3.3lb/day figure includes wastes generated in households, commercial and business establishments, and institutions. Higher figures include those generated by industrial processes, agricultural, construction,

demolition, and sewage wastes. (Section II.G.1.i. describes methods of disposal of various types of waste disposed of offshore.)

New York

Twelve counties in New York, along with nine counties in New Jersey and six regions in Connecticut, make up the Tri-State Regional Planning Commission. This commission seeks solutions to both immediate and long-term problems of the New York metropolitan area. Most of the waste in this area (90 percent) is disposed of in landfills and the remaining in municipal incinerators. Regulations governing proper disposal methods have recently been promulgated but have not yet been approved.

New York City has eight remaining landfills whose life expectancies range from 1976 to 1985 (Table II-134). There are six incinerators, three of which will soon be closed and three of which will be upgraded with the necessary air pollution controls. Approximately 20,000 tons of processible trash is collected each day. In addition, there are

Table II-134 . Tonnage Going to New York City Landfills, Fiscal Year 1973-1974[1]

Landfill	Refuse	Construction Waste	Total	Expected Closing Date
Pelham (Bronx)	508,000	163,000	671,000	1976
Pennsylvania Avenue (Brooklyn)	-	535,000	535,000	1980
Fountain Avenue (Brooklyn)	752,000	688,000	1,440,000	1985
Edgemere (Queens)	90,000	86,000	176,000	1985
Idlewild (Queens)	30,000	446,000	476,000	1976
South Avenue (Richmond)	4,000	134,000	138,000	1978
Brookfield (Richmond)	249,000	36,000	285,000	1977
Fresh Kills (Richmond)	3,106,000	-	3,106,000	1985
T O T A L	4,739,000	2,088,000	6,827,000	

[1]L. O'Reilly, Solid Waste Task Force, personal communication, 1975.

7000 to 8000 tons of construction wastes and 2000 tons of dry solid sewage collected. Over 5000 tons/day of the trash is pyrolyzed and the 1000 tons of residue are used for landfill.[1] Approximately 10,000 tons/day are transported to New Jersey for disposal in the Hackensack Meadow Lands. The city has plans for a resource recovery system that will handle 1500 tons/day and provide supplemental fuel for the Consolidated Edison boilers (Hopper, 1975).

Westchester County has plans for upgrading its three or four existing incinerators and closing the Croton Landfills. It also has plans for a 1500 ton/day resource recovery system to supply energy to a county-owned industrial park (CEQ, 1974a). As part of the Westchester plan. Mt. Vernon intends to build a 400 ton/day gas prolysis plant that will serve the Putnam area (Hopper, 1975).

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[1] L. O'Reilly. Solid Waste Task Force, personal communication, 1975.

Hempstead plans a wet-pulping waste unit for materials and energy recovery for 6000 tons/week. It will recover ferrous metal, aluminum, and glass and will produce electricity (Hopper, 1975).

New Jersey

Nine counties in New Jersey belong to the Tri-State Regional Planning Commission, but the state as a whole has no solid waste plan. In 1973, there were 370 landfills and three or four incinerators (TRIGOM, 1974). Now there are 323 landfills and only one incinerator (which will be closed this year).[1] By 1980, Essex County, Union County-Middlesex County, and the Hackensack Meadowlands, plan to have resource recovery systems that will handle 1000, 2000, and 1000 tons/day of waste respectively. This waste will be used as fuel to provide steam for Public Service Gas and Electric and other industrial steam boilers (CEQ, 1974). The three coastal counties of New Jersey, Atlantic, Cape May and Ocean, use landfills as their primary method of disposal. Because of the varying population due to influxes of summer tourists in these areas, waste load volume varies over a wide range during the year (Table II-135).

Delaware

Delaware has recently completed a state plan for solid waste management which is now available and awaiting approval by the Secretary of the Department of Natural Resources and Environmental Control.

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[1] C. Gungrich, Bureau of Solid Waste Management, personal communication, 1975.

Table II-135. New Jersey Solid Waste Tonnage For 1974[1]

	Municipal	Institutional	Dry Sewage Sludge	Bulky Wastes	Construction/ Demolition	Pesticides	Hazardous Wastes
Atlantic	130,404	6,192	224	4,657	14,114	0	0
Bergen	1,410,613	4,898	0	334,943	117,066	0	0
Burlington	1,342,049	30,441	4,379	42,706	25,659	0	1
Camden	505,487	3,620	172,186	117,004	337,620	0	0
Cape May	21,394	0	542	100,476	2,660	0	0
Cumberland	43,735	2,481	1	936	19,681	0	0
Essex	60,352	6	0	2,589	41,916	0	0
Gloucester	597,336	38,700	0	12,974	177,081	40	3
Hudson	1,069,741	16,529	110	51,264	64,025	0	0
Mercer	522,910	411	0	8,251	40,390	0	0
Middlesex	1,429,726	18,719	1,772	245,106	357,073	2	107
Monmouth	249,516	508,013	156	24,835	174,132	0	0
Ocean	152,126	3,250	2,210	68,395	198,455	0	0
Passaic	8,736	0	0	0	4,270	0	0
Salem	10,550	0	0	28	1,155	0	0
Somerset	33,808	50	0	797	4,802	0	0
Union	5,178	0	0	63	237	0	0

[1]New Jersey Bureau of Solid Waste Management.

Approximately 562,000 tons of solid waste are generated each year in Delaware (Delaware, 1974). There are 40 landfills that are used for disposal of this waste, 22 in New Castle County, 5 in Kent County, and 13 in Sussex County. Not all of these landfills meet the sanitary landfill requirements because of potential ground water pollution and lack of cover. Both of these problems are related to the high water table in the area which makes it impossible to dig deeply without contacting ground water. The landfills have various life expectancies ranging from 1980 to 2000.

A resource recovery system is being developed in Wilmington. It will have an initial capacity of 500 tons per day of unsegregated mixed refuse sludge and 230 tons per day of 8 percent solids digested sewage sludge and a future capacity of 1000 tons per day of mixed refuse and up to 460 tons of sewage sludge. Products recovered for sale or use will include humus, refuse-derived fuel, fuel gas, ferrous and nonferrous metals, glass, paper, and carbon. The refuse-derived fuel will be used as supplemental fuel for utility oil-fired boilers.[1]

Maryland[2]

Each county in Maryland has a solid waste management plan and landfills are used almost exclusively. Ocean City has a sewage

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[1]P. Canzano, Office of Solid Waste, 1975.

[2]R. Forste, Maryland Environmental Service, personal communication, 1975.

sludge incinerator and a new program for baling old tires and creating artificial fishing reefs. Baltimore has a new resource recovery system capable of handling 1000 tons per day that should be fully operable by the end of 1975. The solid waste will be pyrolyzed and the resultant gases burned to produce steam which will be sold to Baltimore Gas and Electric Company. Ferrous metals and glass will also be recovered for sale. A similar system is planned for Texas, Maryland,[1] and is expected to be operating by the end of 1976. The Eastern Shore counties have a high water table similar to that of Delaware. This creates problems for landfills because leachate can contaminate ground water and dirt cover is harder to find. As a way of circumventing these problems, Wicomico County is building a mountain of trash, similar to the Mt. Trashmore in Virginia, which will be converted to a recreation area on completion. Lack of an extensive highway system in this area could create problems in the future if the population, and therefore waste volume, increases to the point that large collection vehicles and central sites would be necessary.

Virginia

In Virginia, each local government is responsible for its own solid waste disposal system. Table II-136 presents the estimated tonnages and the method of disposal for 1975 in most of the areas that might be affected by the proposed action. Landfilling is the most common method of disposal although some areas use incinerators. In the Norfolk area, incinerators are used to provide steam for Navy ships

[1] Located north of Baltimore, in Baltimore County, Maryland.

Table II-136. Status of Solid Waste Disposal in Political Subdivisions in Virginia Bordering the Atlantic Ocean and Chesapeake Bay[1]

Political Subdivision	Estimated Quantity of Solid Waste Tons/Year[2]	Method of Disposal	Projected Disposal
Norfolk City	300,000	Landfill and incineration	In the S.E. Planning District, an authority has been created to develop regional energy recovery system.
Virginia Beach	200,000	Landfill	
Portsmouth	110,000	Landfill and incineration	
Chesapeake	95,000	Landfill	
Hampton	125,000	Landfill	Peninsula Planning District working on plans for energy recovery system.
Newport News	140,000	Landfill and incineration	
York County	35,000	Landfill	May or may not be included in Peninsula Plan.
Gloucester County	15,000	Landfill	Area sufficient for period of years.
Mathews County	8,000	Landfill	Short of suitable land.
Middlesex County	6,500	Landfill	Area sufficient for period of years.
Lancaster County[3]	10,000	Landfill	Area sufficient for period of years.
Northumberland County[3]	10,000	Landfill	Area sufficient for period of years.
Accomack County	29,000	Landfill	Area sufficient for period of years.
Northampton County	15,000	Landfill	Area sufficient for period of years.

[1]R.E. Dorer, Bureau of Solid Wastes and Vector Control, personal communication, 1975.

[2]Tonnage estimated from population figures since few places measure such amounts.

[3]Lancaster, Northumberland, and Richmond Counties cooperate in the operation of a single disposal site.

in harbor and for the Army and NASA installations. An unusual type of landfill has also recently been completed in Virginia Beach. A mountain of trash was compacted, covered with dirt, and converted to a recreational site. Mt. Trashmore has proved to be so successful as a park that a second such mountain has been begun.

Philadelphia[1]

The volume of household wastes collected in the Philadelphia area is approximately one million tons per year. Normal methods of disposal include landfills in New Jersey and the six municipal incinerators. Two of these incinerators will be upgraded in the future and the four remaining ones will be closed. The city also has plans for a resource recovery system that will handle 1600 tons per day and provide steam for sale to local power companies as well as recovered materials. Both collection and disposal of commercial and industrial wastes are handled by private companies.

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[1]J. Siderer, City of Philadelphia, Sanitation Division, personal communication, 1975.

2. Socio-Economic[1]

a. Population

In 1970 the population for the Mid-Atlantic coastal region totaled 27,052,549 persons, representing 58 percent of the combined population of the six states and 13.3 percent of the population of the United States. The land area which this population inhabits accounts for 22.8 percent of the land in the six Mid-Atlantic states and less than one percent of the entire United States land area. Figure II-86 is a reference map of the area which defines the Mid-Atlantic Coastal Region.

Between 1950 and 1960, the population in the coastal region did not show as great a percentage increase as the total population of the six states or the United States. During 1960 and 1970 the population did increase by 13 percent, which was slightly lower than the United States as a whole, but somewhat higher than that of the Mid-Atlantic states.

Between 1950 and 1960 the major metropolitan areas, New York and Philadelphia, experienced great increases in the more suburban areas, with slow growth in the core city or a decline as in the case of Philadelphia. Less populated areas surrounding or in close proximity to the major cities generally experienced the most growth. Figure II-87 is a representation of the change in population within the counties between 1950 and 1960.

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[1]An overview of the socio-economic characteristics of the Atlantic Coastal region is included in the Final EIS for the Proposed Increase in Oil and Gas Leasing on the Outer Continental Shelf, Vol. 1, pp.448-494.

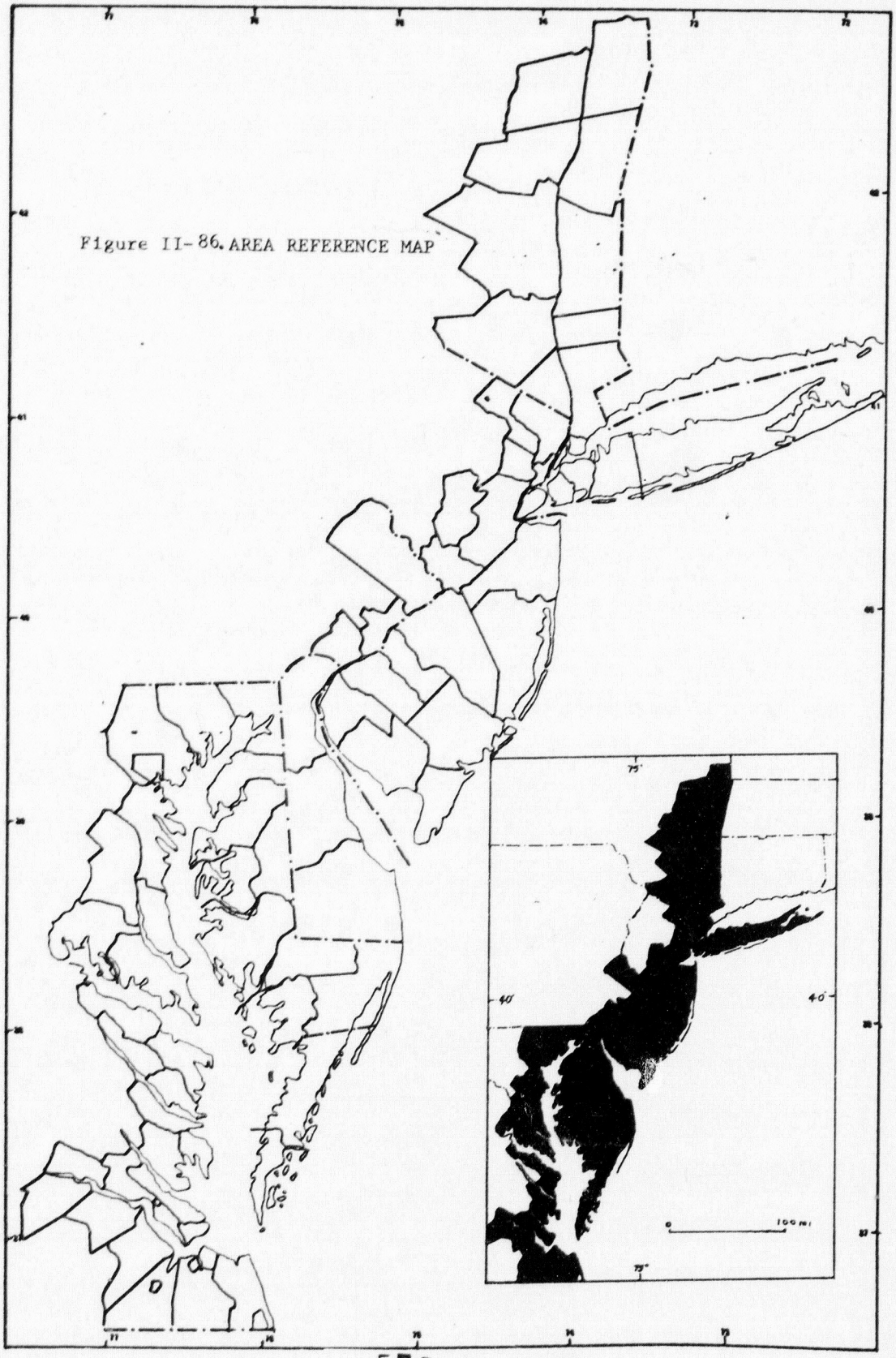

Figure II-86. AREA REFERENCE MAP

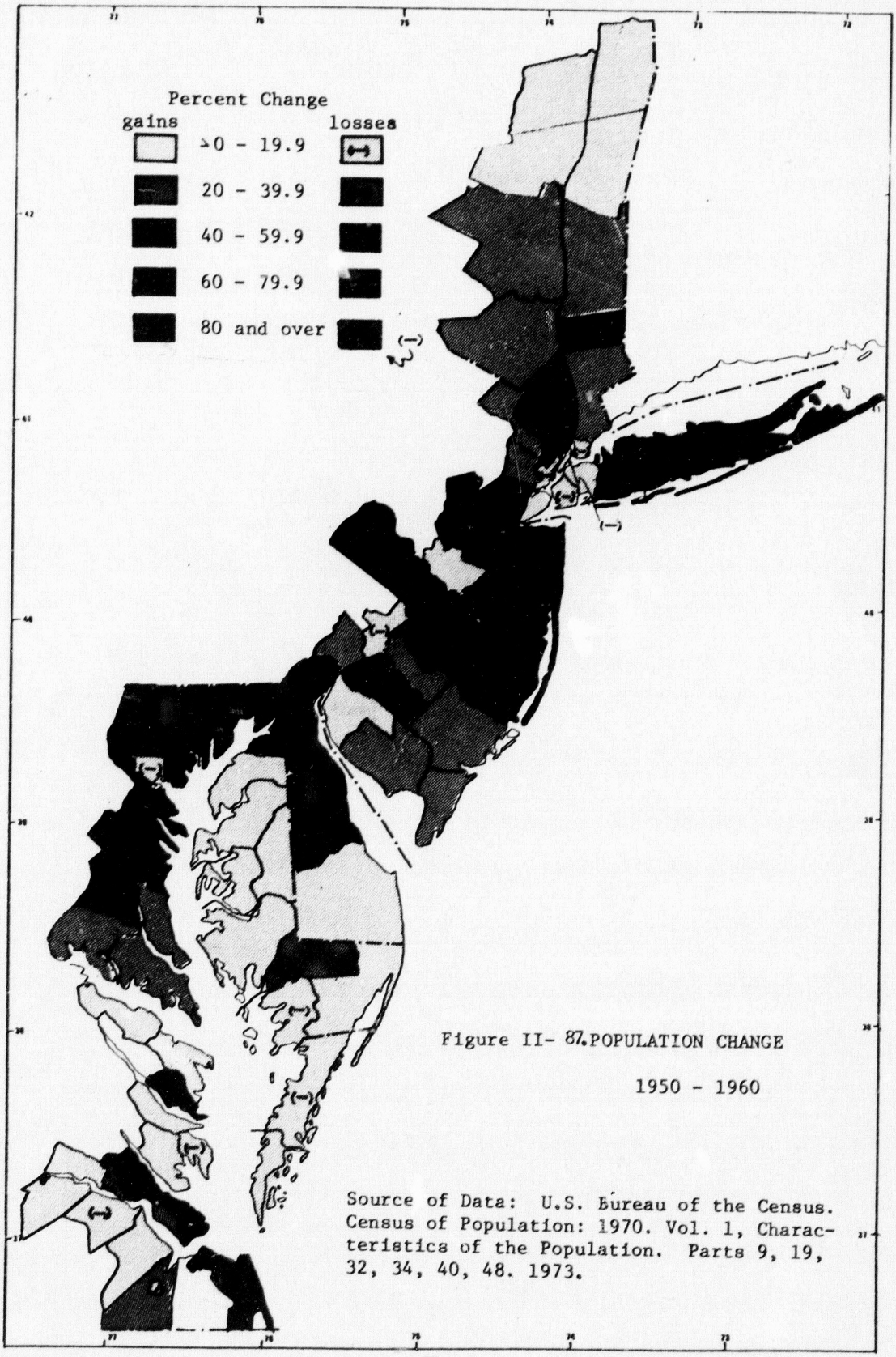

Figure II- 87. POPULATION CHANGE

1950 - 1960

Source of Data: U.S. Bureau of the Census. Census of Population: 1970. Vol. 1, Characteristics of the Population. Parts 9, 19, 32, 34, 40, 48. 1973.

During the decade between 1960 and 1970, population trends established during the previous decade continued, but generally at a slower pace. Population changes within the coastal region between 1960 and 1970 are shown in Figure II-88. Table II-137 contains a summary of population figures and changes for the two decade period between 1950 and 1970.

The region is highly urbanized; 79 percent of the population of the six states lived in urban areas in 1970. Ninety-one percent of the population of the coastal region lived in urbanized areas as compared to 73.5 percent for the entire United States. Although only 58 percent of the total population of the six states lived in the coastal region, it contained 67 percent of the urbanized population of the six states. Urban growth in the region, between 1960 and 1970 took place mostly in those counties in close proximity to the major cities. The shoreline counties of New York, New Jersey and parts of Maryland exhibited high increases in their urbanized populations. Changes in the urban population between 1960 and 1970 are presented in Figure II-89.

Many of the major cities in the area--New York, Philadelphia, Baltimore, Norfolk--experienced net out migration. Counties which make up the suburban ring around major cities showed some growth as a result of net in-migration. The shoreline counties of New Jersey, mainland Maryland, and a few in Virginia had a high level

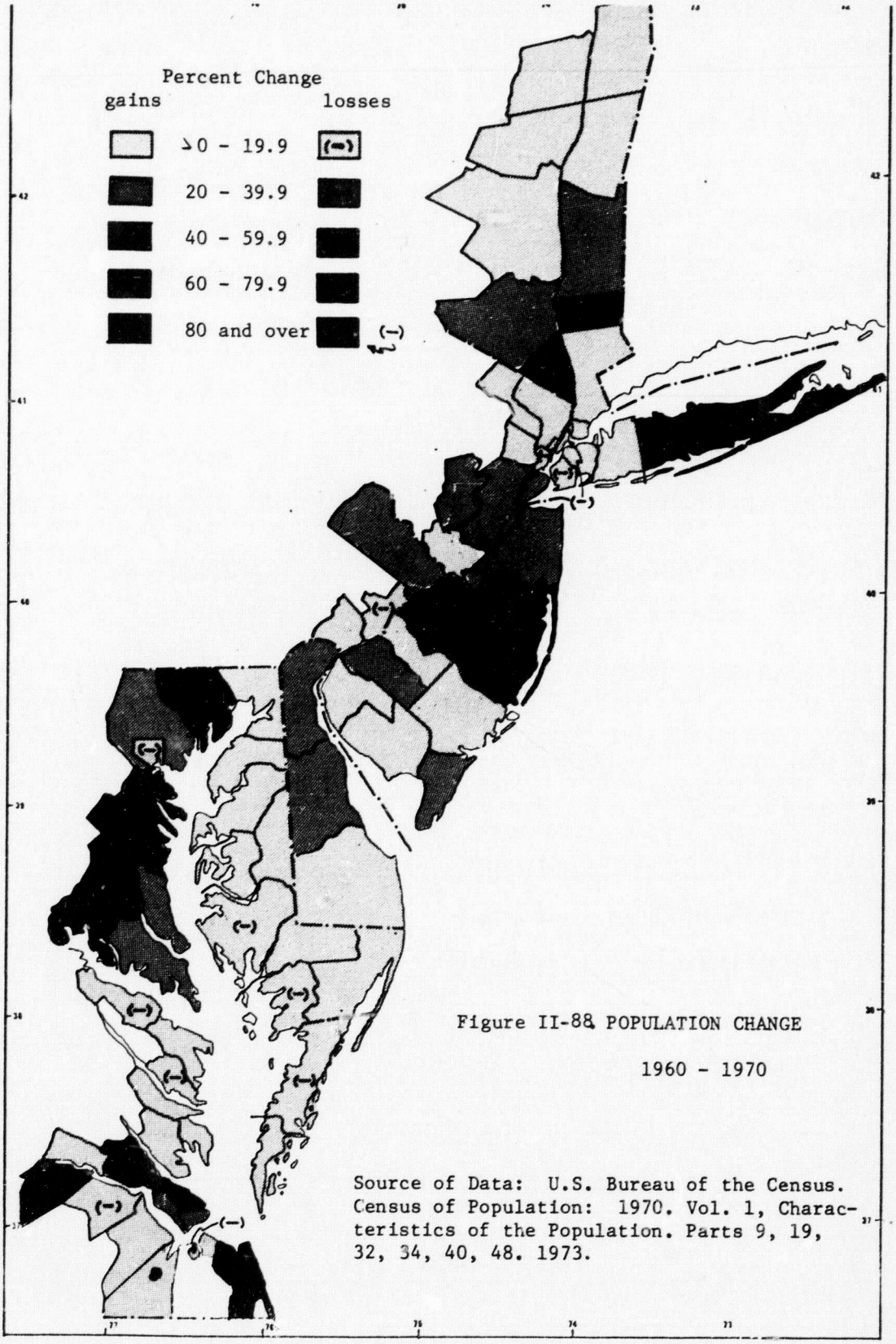

Figure II-88 POPULATION CHANGE

1960 - 1970

Source of Data: U.S. Bureau of the Census. Census of Population: 1970. Vol. 1, Characteristics of the Population. Parts 9, 19, 32, 34, 40, 48. 1973.

Table II-137. Population Change in the Mid-Atlantic Coastal Region, 1950-1970

	Percent Change 1950-1960	Percent Change 1960-1970
United States	18.5	13.3
Mid-Atlantic Coastal Region	13.8	12.9
State of New York	13.2	8.7
New York State Coastal Area	12.5	8.9
Albany	14.0	5.1
Bronx	-1.8	3.3
Columbia	9.6	8.9
Dutchess	28.7	26.3
Greene	9.1	5.6
Kings	-4.0	-1.0
Nassau	93.3	9.8
New York	-13.4	-9.4
Orange	20.7	20.6
Putnam	56.2	78.7
Queens	16.7	9.8
Rensselaer	7.5	7.0
Richmond	15.9	33.1
Rockland	53.2	68.1
Suffolk	141.5	68.7

Table II-137. Continued.

	Percent Change 1950-1960	Percent Change 1960-1970
State of New York (Continued)		
Ulster	28.3	18.9
Westchester	29.3	10.5
State of New Jersey	25.5	18.2
New Jersey Coastal Area	24.3	16.3
Atlantic	21.5	8.8
Bergen	44.7	15.1
Burlington	65.2	43.9
Camden	30.4	16.4
Cape May	30.8	22.7
Cumberland	20.6	13.6
Essex	1.9	.7
Gloucester	47.0	24.4
Hudson	-5.7	-.2
Mercer	15.9	14.1
Middlesex	63.8	34.6
Monmouth	48.4	37.8
Ocean	91.2	92.6
Passiac	20.6	13.3
Salem	18.6	2.8
Somerset	45.3	37.8
Union	26.7	7.7

Table II-137 Continued.

	Percent Change 1950-1960	Percent Change 1960-1970
State of Pennsylvania	7.8	4.2
Pennsylvania Coastal Area	-12.4	3.5
Bucks	113.4	34.5
Delaware	33.5	8.5
Philadelphia	-26.1	-2.7
State of Delaware	40.3	22.8
Kent	73.4	24.7
Newcastle	40.5	25.5
Sussex	19.3	9.8
Commonwealth of Virginia	19.5	17.2
Virginia Coastal Area	35.2	38.9
Accomack	-9.4	-5.3
Charles City	17.5	12.1
Gloucester	15.2	18.0
Isle of Wight	15.1	6.5
James City	82.7	54.7
Lancaster	61.8	-0.5
Mathews	-0.4	0.7

Table II- 137.Continued.

	Percent Change 1950-1960	Percent Change 1960-1970
State of Virginia (Continued)		
Middlesex	5.9	-0.4
Nansemond	24.3	12.1
Northampton	1.9	-14.9
Northumberland	1.7	9.3
Prince George	3.0	43.5
Surry	0	-5.4
Westmoreland	8.8	10.0
York	83.7	53.8
Independent Cities		
Chesapeake City	N.A.	N.A.
Hampton	46.3	35.3
Hopewell	75.1	31.2
Newport News	38.2	21.6
Norfolk	42.8	1.0
Portsmouth	43.4	-3.3
Suffolk	2.2	21.8
Virginia Beach	50.1	N.A.
Williamsburg	14.4	32.7

Table II-137. Continued.

	Percent Change 1950-1960	Percent Change 1960-1970
State of Maryland	32.3	26.5
Maryland Coastal Area	29.9	23.7
Anne Arundel	76.0	44.0
Baltimore	82.0	26.1
Calvert	30.8	30.7
Caroline	6.7	1.6
Cecil	45.1	10.1
Charles	39.1	46.4
Dorchester	6.7	-0.9
Harford	48.2	50.4
Kent	13.2	4.3
Prince George	84.1	84.8
Queen Annes	26.4	11.2
St. Mary's	62.8	21.8
Somerset	-5.4	-3.6
Talbot	11.1	9.8
Wicomico	23.7	10.6
Worcester	2.5	3.0
Baltimore City	-1.1	-3.5

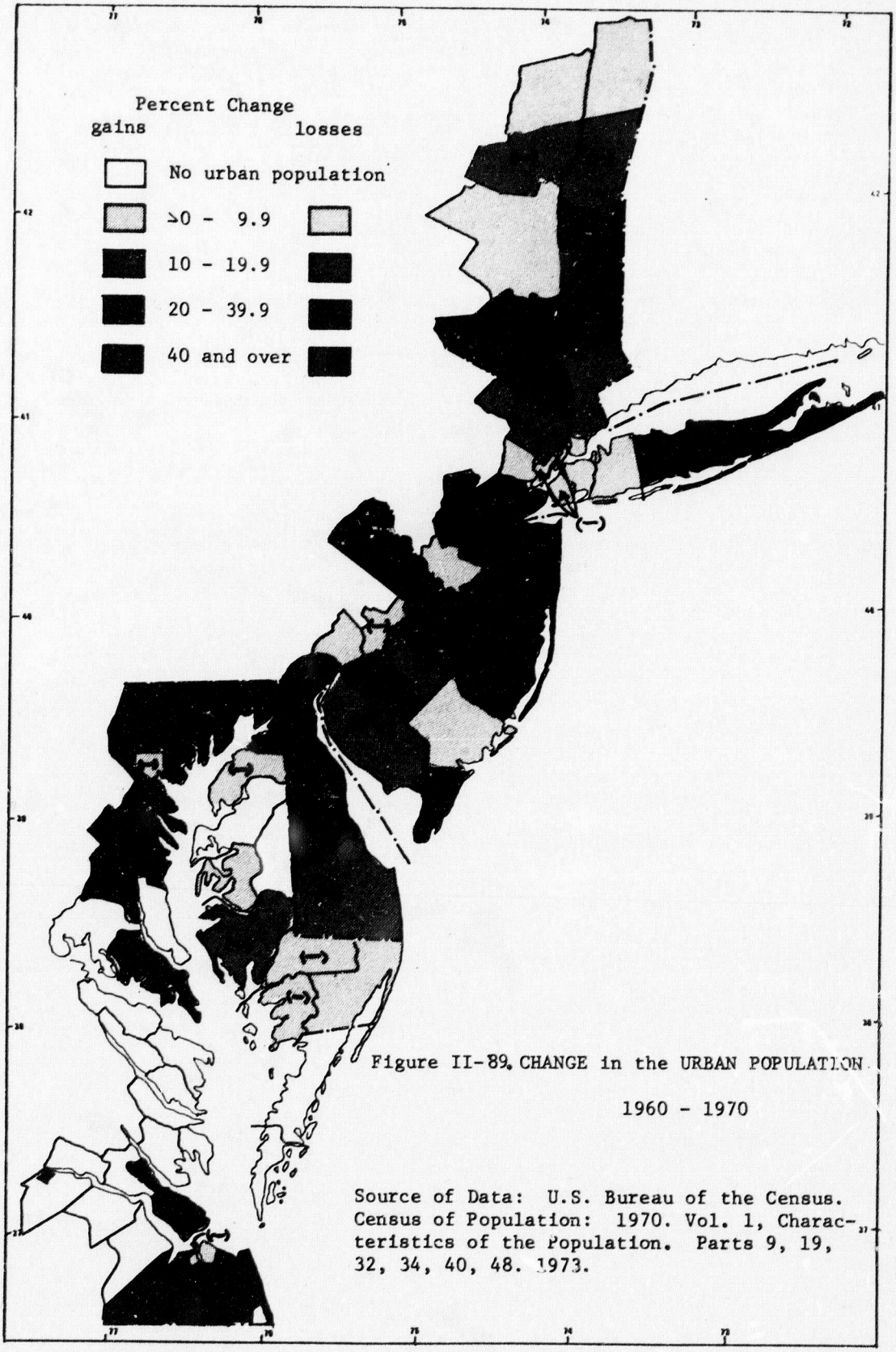

Figure II-89. CHANGE in the URBAN POPULATION

1960 - 1970

Source of Data: U.S. Bureau of the Census. Census of Population: 1970. Vol. 1, Characteristics of the Population. Parts 9, 19, 32, 34, 40, 48. 1973.

of in-migration. There were also many shoreline counties especially in Maryland and Virginia which experienced net out migration. Such out migration probably resulted from the economic climate producing a need to seek greater job opportunities in other areas. Net migration is presented in Figure II-90 .

Only nine percent of the coastal region's population lived in rural areas in 1970 as compared to 20.6 percent for the Mid-Atlantic states and 26.5 percent for the entire United States. The most rural counties, which generally experienced little growth and oft-times lost population during the decade of the sixties, are located in the southern portion of the coastal region. All of the Maryland and Virginia counties, except four, which are adjacent to the Atlantic or Chesapeake Bay had rural populations which constituted more than 50 percent of their total population during the last census year. The change in the rural population between 1960 and 1970 is shown in Figure II- 91. The urban and rural population figures for the area's counties and independent cities appear in Table II- 138.

Five of the six states in the region rank among the ten most densely populated in the country: New Jersey (2), Maryland (6), New York (7), Delaware (8), and Pennsylvania (9). While there were 57.5 persons per square mile in the United States as a whole, the Mid-Atlantic states averaged 308.5 persons per square mile. The population density for the coastal region, 1066.6 persons per square mile,

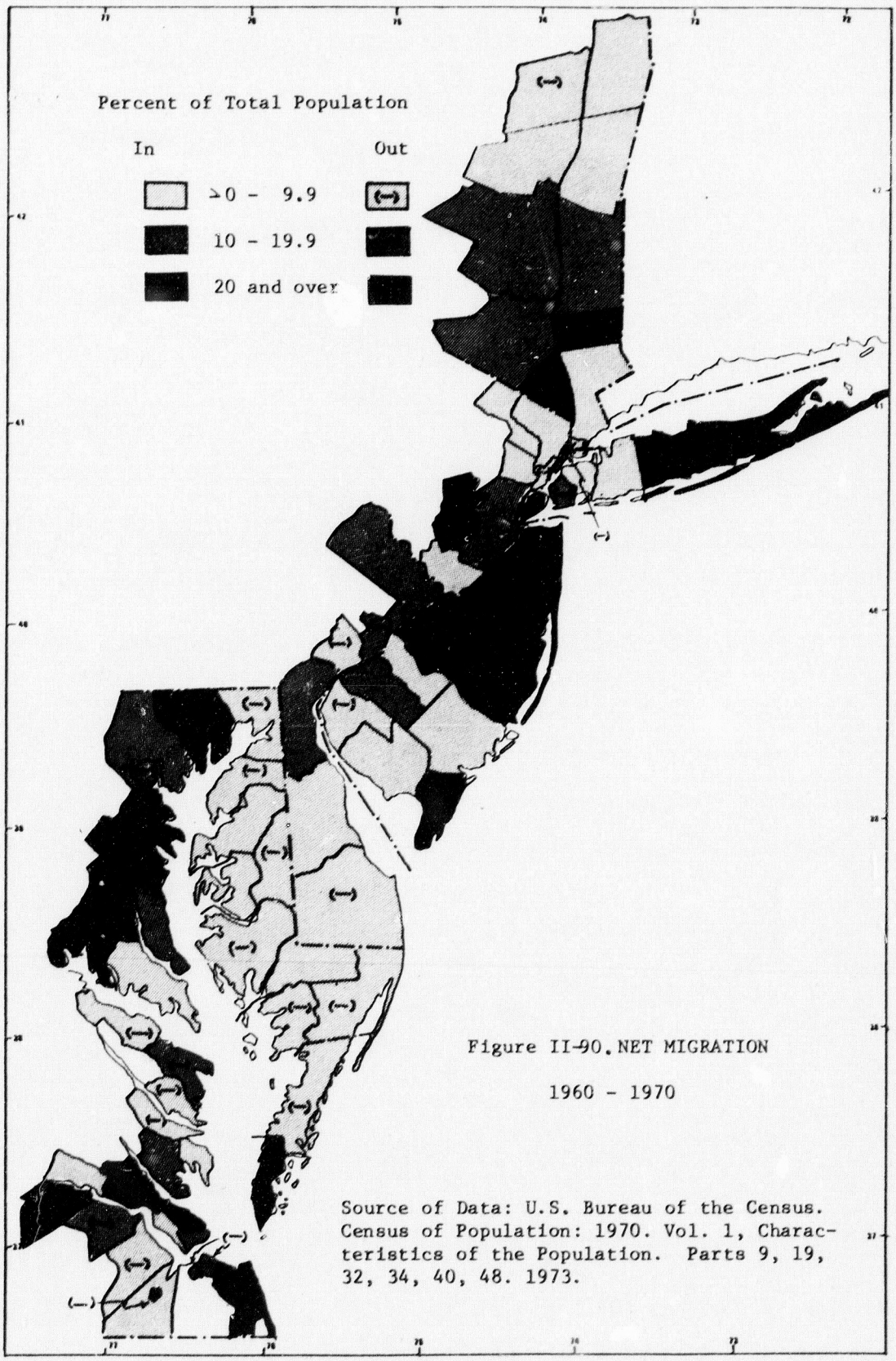

Figure II-90. NET MIGRATION

1960 - 1970

Source of Data: U.S. Bureau of the Census. Census of Population: 1970. Vol. 1, Characteristics of the Population. Parts 9, 19, 32, 34, 40, 48. 1973.

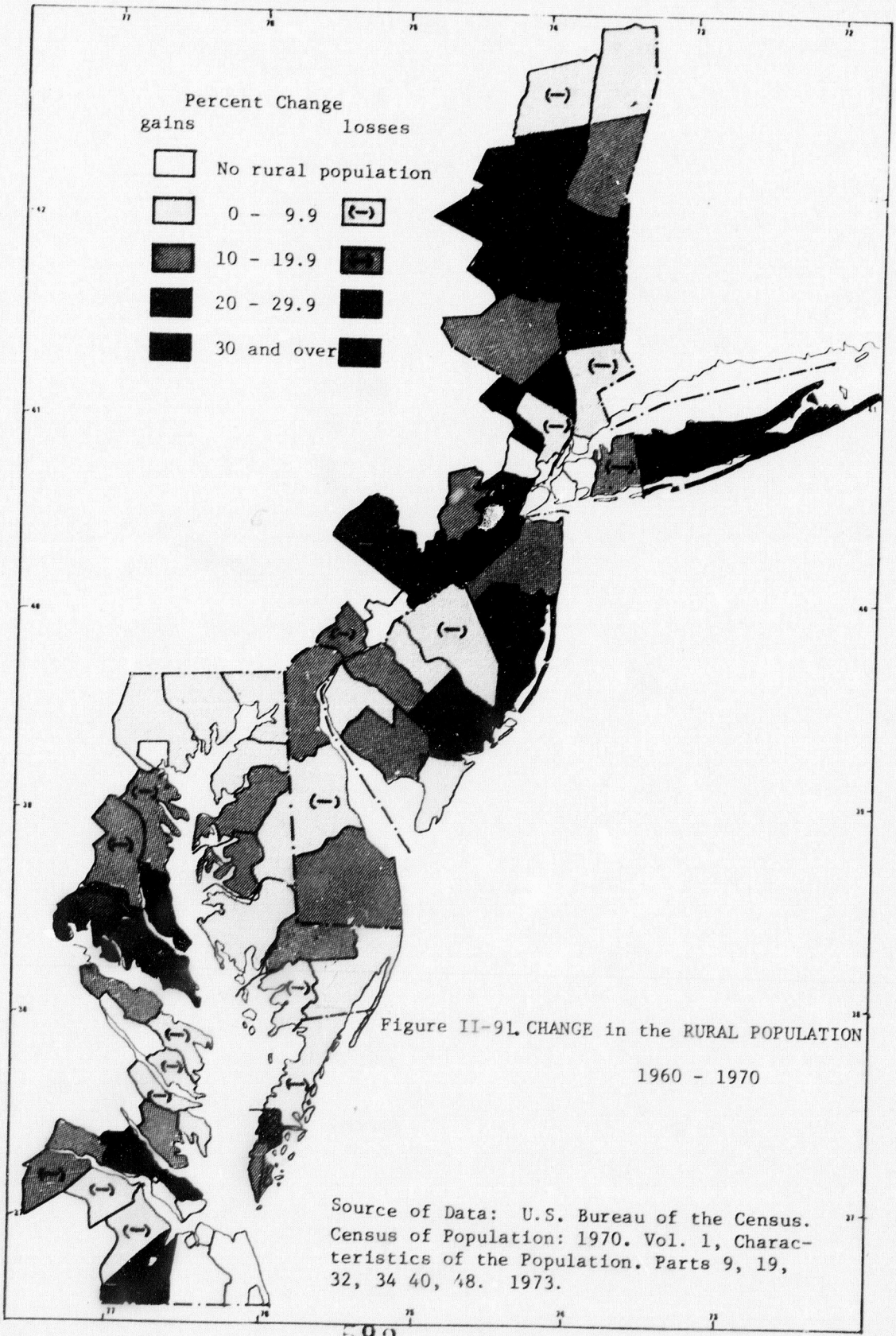

Figure II-91. CHANGE in the RURAL POPULATION

1960 - 1970

Source of Data: U.S. Bureau of the Census. Census of Population: 1970. Vol. 1, Characteristics of the Population. Parts 9, 19, 32, 34 40, 48. 1973.

Table II- 138. Urban and Rural Population in the Mid-Atlantic Coastal Region

1960 And 1970

(Percent)

	Density Population/ Square Mile	1970		1960		Change 1960-1970	
		Urban	Rural	Urban	Rural	Urban	Rural
United States	57.5	73.5	26.5	69.9	30.1	19.2	-0.3
Mid-Atlantic Coastal/Region	1066.6	91.2	8.8	90.5	9.5	13.7	4.9
State of New York	381.3	85.6	14.4	85.4	14.6	8.9	7.5
New York Coastal Area	1,666.4	94.4	.6	93.8	6.2	9.6	-2.6
Albany	545.1	85.8	14.2	83.5	16.5	7.9	-9.4
Bronx	35,895.1	100.0	-	100.0	-	3.3	-
Columbia	79.9	17.4	82.6	23.4	76.6	19.3	17.5
Dutchess	273.4	42.8	57.2	41.8	58.2	29.1	24.3
Greene	50.7	16.0	84.0	27.6	72.4	-38.7	22.6
Kings	37,171.6	100.0	-	100.0	-	-1.0	-
Nassau	4,941.5	99.7	.3	99.7	.3	9.9	-15.9
New York	66,923.2	100.0	-	100.0	-	-9.4	-

Table II-138. Continued.

	Density Population/ Square Mile	1970		1960		Change 1960-1970	
		Urban	Rural	Urban	Rural	Urban	Rural
New York (Continued)							
Orange	266.1	51.1	48.9	50.7	49.3	21.7	19.6
Putnam	245.4	37.8	62.2	9.7	9.0	599.2	23.0
Queens	18,393.3	100.0	-	100.0	-	9.8	-
Rensselaer	299.3	63.7	36.3	64.6	35.4	5.4	9.8
Richmond	5,093.8	100.0	-	100.0	-	33.1	-
Rockland	1,306.3	96.5	3.5	76.0	24.0	113.5	-75.5
Suffolk	1,210.9	89.7	10.3	72.3	27.7	109.4	-37.2
Ulster	123.8	37.7	62.3	42.0	58.0	6.8	27.6
Westchester	2,018.3	93.9	6.1	92.7	7.3	12.0	-7.9

Table II-138. Continued.

	Density Population/ Square Mile	1970		1960		Change 1960-1970	
		Urban	Rural	Urban	Rural	Urban	Rural
State of New Jersey	953.1	88.9	11.1	88.6	11.4	18.6	14.8
New Jersey Coastal Area	1143.3	91.0	9.0	90.9	9.1	16.6	14.7
Atlantic	307.6	81.1	18.9	83.7	16.2	5.3	27.1
Bergen	3,837.7	99.7	.3	99.6	.4	15.2	-3.8
Burlington	394.5	80.5	19.5	71.3	28.7	62.5	-2.2
Camden	2,064.7	95.9	4.1	95.4	4.6	17.0	3.0
Cape May	223.0	61.6	38.4	54.0	46.0	39.9	2.5
Cumberland	242.7	73.3	26.7	72.8	27.2	14.4	11.5
Essex	7,153.7	100.0	-	99.7	.3	1.0	-
Gloucester	524.9	70.8	29.2	68.1	31.9	33.3	17.0
Hudson	12,963.1	100.0	-	100.0	-	-0.2	-
Mercer	1,333.2	84.0	16.0	89.2	10.8	7.4	69.4

Table II-138.Continued.

	Density Population/ Square Mile	1970		1960		Change 1960-1970	
		Urban	Rural	Urban	Rural	Urban	Rural
State of New Jersey (Continued)							
Middlesex	1,871.2	95.4	4.6	90.8	9.2	41.3	-32.6
Monmouth	965.1	81.8	18.2	77.5	22.5	45.1	10.9
Ocean	324.7	44.3	55.7	35.7	64.3	138.9	66.8
Passaic	2,399.9	96.2	3.8	98.0	2.0	11.2	144.6
Salem	165.3	54.2	45.8	49.8	50.2	11.9	6.2
Somerset	646.2	76.5	23.5	61.9	38.1	70.3	15.0
Union	5,273.0	100.0	-	100.0	-	7.7	-

Table II- 138. Continued.

	Density Population/ Square Mile	1970		1960		Change 1960-1970	
		Urban	Rural	Urban	Rural	Urban	Rural
State of Pennsylvania	262.3	71.5	28.5	71.6	28.4	4.1	4.5
Pennsylvania Coastal Area	3,197.1	96.0	4.0	96.6	3.4	2.9	19.5
Bucks	676.0	76.2	23.8	75.3	24.7	36.3	29.2
Delaware	3,261.1	96.8	3.2	96.0	4.0	9.4	-13.4
Philadelphia	15,105.5	100.0	0.0	100.0	0.0	-2.7	-
State of Delaware	276.5	72.2	27.8	65.6	34.4	35.1	-0.6
Kent	137.9	38.9	61.1	19.4	80.6	150.1	-5.5
Newcastle	880.9	91.3	8.7	86.6	13.4	32.3	18.4
Sussex	84.6	14.2	85.8	18.7	81.3	-17.0	15.9

Table II-138. Continued.

	Density Population/ Square Mile	1970		1960		Change 1960-1970	
		Urban	Rural	Urban	Rural	Urban	Rural
State of Maryland	396.6	76.6	23.4	72.7	27.3	33.3	8.3
Maryland Coastal Area	459.1	80.5	2.7	76.3	23.7	30.6	1.9
Anne Arundel	703.4	67.3	32.7	47.1	52.9	105.5	-10.9
Baltimore	1,038.6	88.7	11.3	85.2	14.8	31.3	3.6
Calvert	95.3	-	100.0	-	100.0	-	30.7
Caroline	61.6	-	100.0	-	100.0	-	1.6
Cecil	147.2	19.9	80.1	12.4	87.6	77.3	0.6
Charles	103.9	15.5	84.5	-	100.0	-	23.8
Dorchester	49.5	39.4	60.6	58.7	41.3	-5.3	2.2
Harford	254.7	51.7	48.3	29.3	70.7	165.2	2.8
Kent	57.5	21.5	78.5	23.3	76.7	-3.5	6.7
Prince Georges	1,362.0	92.2	7.8	83.4	16.6	104.4	-13.1

Table II -138. Continued

	Density Population/ Square Mile	1970		1960		Change 1960-1970	
		Urban	Rural	Urban	Rural	Urban	Rural
State of Maryland (Continued)							
Queen Annes	49.1	-	100.0	-	100.0	-	11.2
St. Mary's	127.0	19.3	80.7	18.1	81.9	29.8	20.0
Somerset	55.8	16.3	83.7	18.0	82.0	-13.1	-1.5
Talbot	90.7	28.8	71.2	29.4	70.6	7.4	10.7
Wicomico	142.4	28.1	71.9	33.2	66.8	-6.5	19.0
Worcester	51.0	14.6	85.4	14.0	86.0	7.3	2.3
Baltimore City	11,612.3	100.0	-	100.0	-	-3.5	-

Table II-138. Continued.

	Density Population/ Square Mile	1970		1960		Change 1960-1970	
		Urban	Rural	Urban	Rural	Urban	Rural
Commonwealth of Virginia	116.9	63.1	36.9	55.6	44.4	33.1	2.8
Virginia Coastal Area	288.4	80.9	19.1	76.5	23.5	46.9	12.8
Accomack	60.9	-	100.0	-	100.0	-	-5.3
Charles City	34.0	-	100.0	-	100.0	-	12.1
Gloucester	61.7	-	100.0	-	100.0	-	18.0
Isle of Wight	57.7	14.8	85.2	-	100.0	-	-9.3
James City	117.5	7.8	92.2	-	100.0	-	42.6
Lancaster	66.6	-	100.0	-	100.0	-	-0.5
Mathews	80.5	-	100.0	-	100.0	-	0.7
Middlesex	48.4	-	100.0	-	100.0	-	-0.4
Nansemond	86.2	-	100.0	8.4	91.6	-100.0	22.4
Northampton	65.6	-	100.0	-	100.0	-	-14.9
Northumberland	48.6	-	100.0	-	100.0	-	-9.3
Prince George	105.4	42.7	57.3	-	100.0	-	-17.8

Table II-138. Continued.

	Density Population/ Square Mile	1970		1960		Change 1960-1970	
		Urban	Rural	Urban	Rural	Urban	Rural
Commonwealth of Virginia (Continued)							
Surry	21.2	-	-	-	100.0	-	-5.4
Westmoreland	53.0	-	-	-	100.0	-	10.0
York	257.4	23.8	76.2	27.6	72.4	32.8	61.9
Independent Cities							
Chesapeake City	262.7	92.2	7.8	N.A.	N.A.	N.A.	
Hampton	2,196.0	100.0	-	100.0	-	35.3	-
Hopewell	2,607.9	100.0	-	100.0	-	31.2	-
Newport News	2,002.6	100.0	-	100.0	-	21.6	-
Norfolk	5,810.4	100.0	-	100.0	-	1.0	-
Portsmouth	3,826.3	100.0	-	100.0	-	-3.3	-
Suffolk	4,929.0	100.0	-	100.0	-	-21.8	-
Virginia Beach	664.5	96.9	3.1	100.0	-	1000.0+	-
Williamsburg	1,813.8	100.0	-	100.0	-	32.7	-

was approximately four times as great as that of the Mid-Atlantic states and 18 times as great as the average density for the United States. This figure reflects a range in county densities from 21.2 persons per square mile in Surrey County, Virginia to 66,923.2 in New York County (Manhattan). The most dense population centers are in the metropolitan areas and other major cities, such as Baltimore, Hampton, Norfolk, etc. Generally, the least densely populated counties are the shoreline counties of Maryland and Virginia which abut the Atlantic Ocean and Chesapeake Bay. Table II-138 also includes density figures for the region which are represented in Figure II-92.

The median age in the region's coastal counties ranges from 22.0 years to 41.3 years. The support population, persons age 18 to 64, ranges from approximately 50 percent of the population in Charles City and Calvert Counties to 77 percent of the population of Williamsburg. Counties having larger, more dynamic, and diverse economic bases apparently contain higher percentages of the support population. Those persons 65 and over, who have generally left the labor force, are referred to as the older dependent population. Persons in this category account for as little as 2.7 percent of the population of Prince Georges County, Maryland, to as much as 20.0 percent of the population of Mathews County, Virginia. Generally, higher percentages of this segment of the population are found in shoreline counties. The inner cities of metropolitan areas also contain a relatively

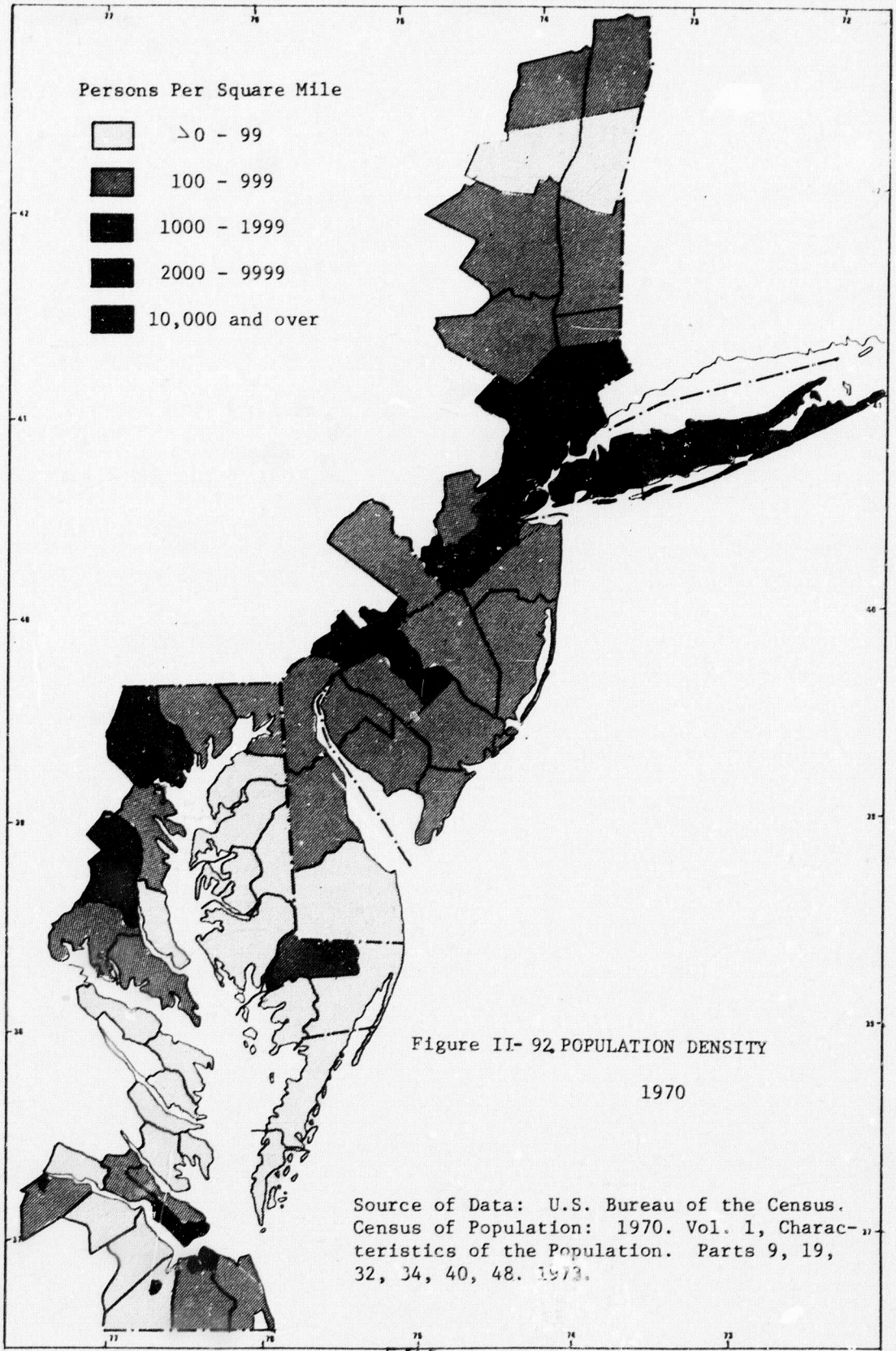

Figure II- 92 POPULATION DENSITY

1970

Source of Data: U.S. Bureau of the Census. Census of Population: 1970. Vol. 1, Characteristics of the Population. Parts 9, 19, 32, 34, 40, 48. 1973.

high percentage of the older dependent population. Figure II- 93 is a representation of the older dependent population of the area in 1970.

Concentrations of the minority population are found in the inner cities and more highly populated counties in the northern segment of the coastal region. The minority population accounts for greater percentages of the county populations in the more southernly sections of the area. In the more southern portions of the area, the higher concentrations of the minority population are found in the more rural areas. Figure II- 94 depicts the distribution of the minority population of the area in 1970.

From the foregoing profiles of the coastal region it can be concluded that the population trends and characteristics may vary widely between counties. It should be noted that the diversity within each county may be as great as it is between counties.

b. Regional Economy

This section briefly discusses economic data for the year 1975 that has been generated by an economic model study made by the BLM New York OCS Office. A more detailed description of this study, Technical Paper Number 1 - New York OCS Office: Economic Study of the Possible Impacts of a Potential Baltimore Canyon Sale, is available upon request from the National Technical Information Service, Accession No. PB249199/AS. Also available from the Bureau of Land Management.

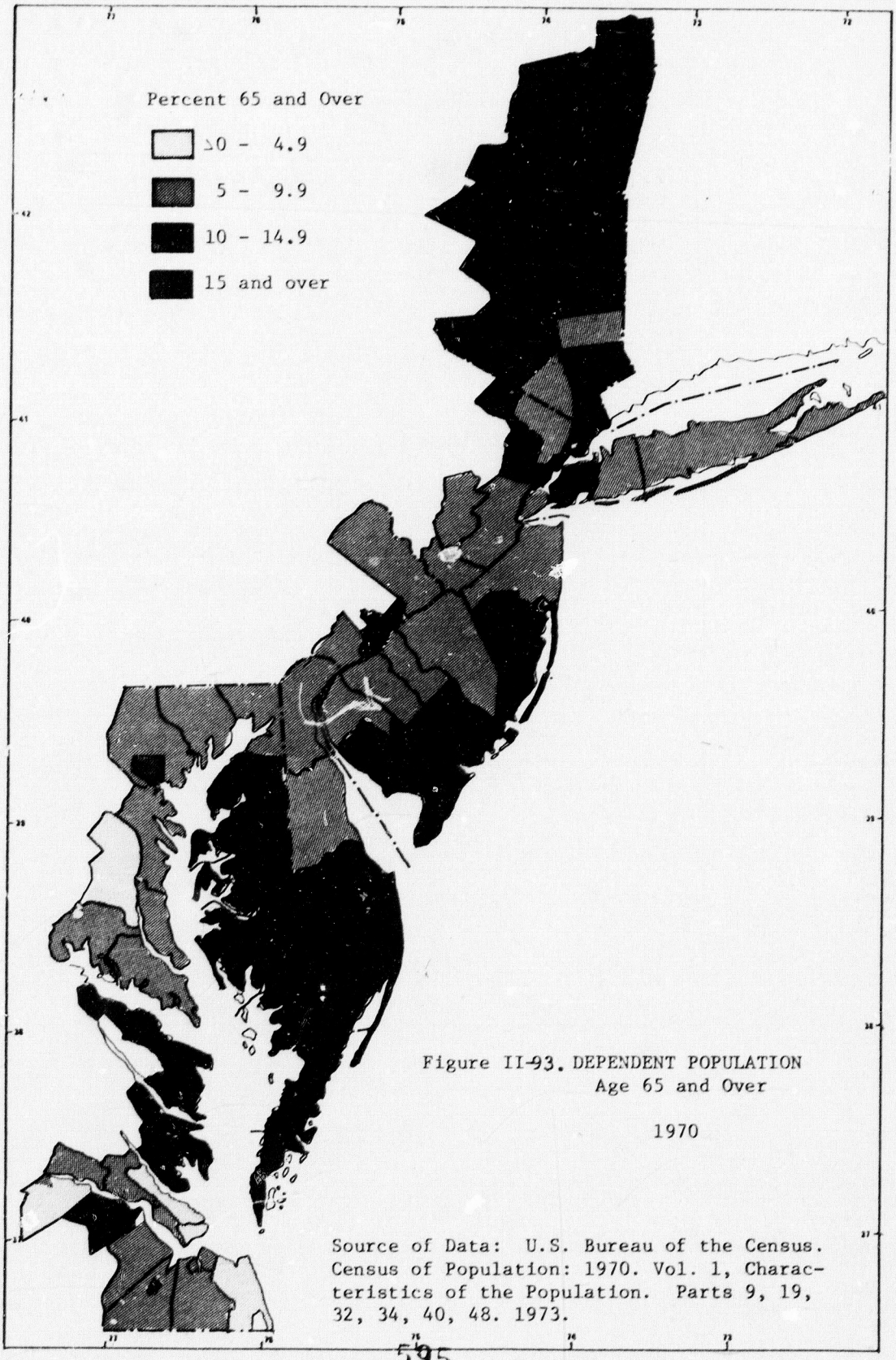

Figure II-93. DEPENDENT POPULATION
Age 65 and Over

1970

Source of Data: U.S. Bureau of the Census. Census of Population: 1970. Vol. 1, Characteristics of the Population. Parts 9, 19, 32, 34, 40, 48. 1973.

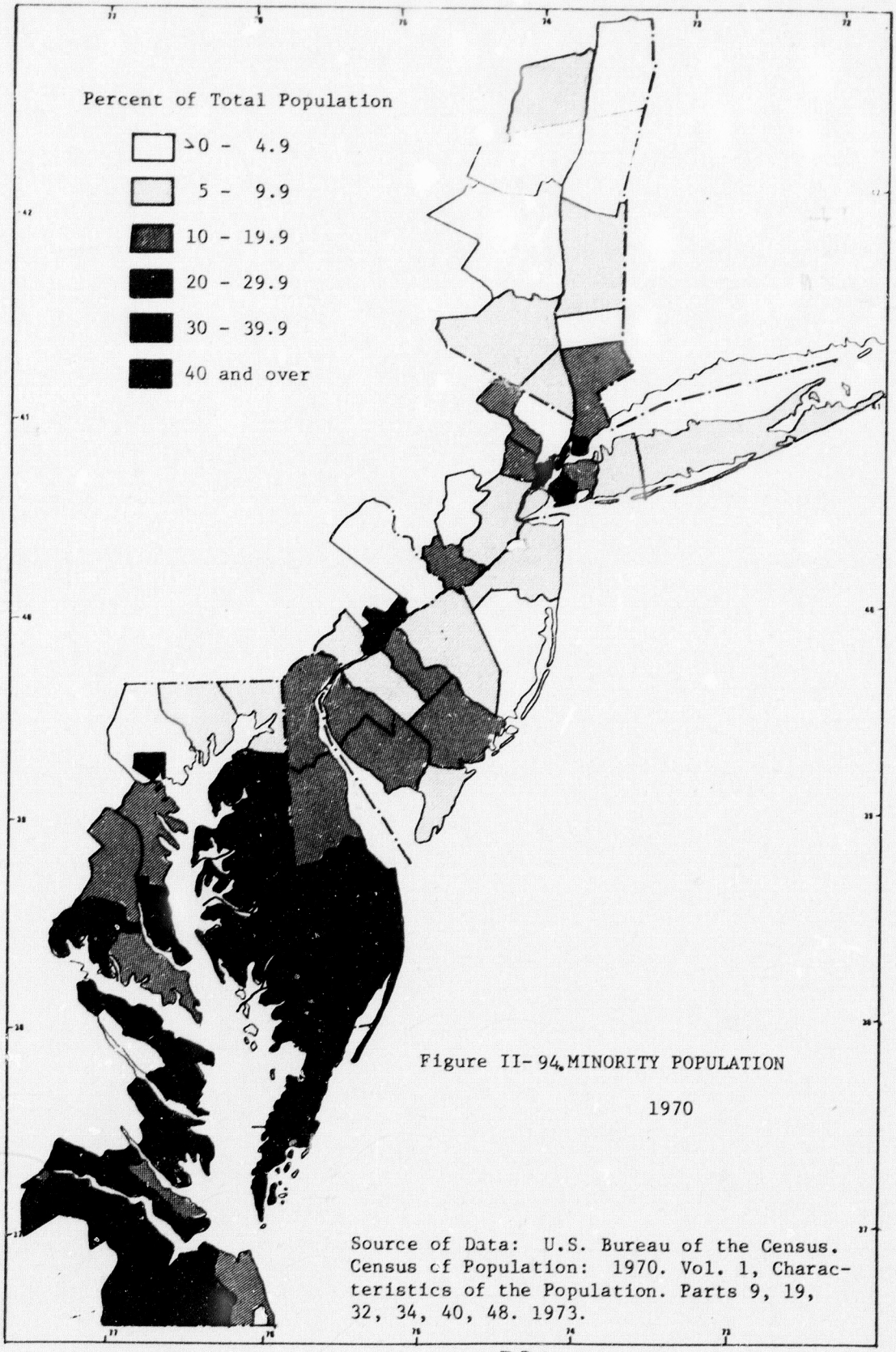

Figure II-94. MINORITY POPULATION

1970

Source of Data: U.S. Bureau of the Census. Census of Population: 1970. Vol. 1, Characteristics of the Population. Parts 9, 19, 32, 34, 40, 48. 1973.

Most persons in the Mid-Atlantic coastal region work in retail stores, State and local governments, medical and educational institutions, finance, insurance, real estate firms, and machines and other manufacturing firms. The fewest number of persons are employed in the petroleum refining, nonpetroleum mining, water utility, petroleum mining, forestry, and fishery sectors.

The Mid-Atlantic coastal region contains 14.3 percent of the total civilian labor force of the United States. The 8.8 percent unemployment rate in the region compares with a 9.0 percent unemployment rate for the nation as a whole. Employment earnings in 1975 vary considerably throughout the region from only $13.2 million in Charles City County, Virginia, to $13.3 billion in New York County, New York (Manhattan).

The per capita income of the Mid-Atlantic coastal region ($5465) is greater than that for the nation as a whole ($4511). Within the region, per capita income varies from a low of $2152 for Chesapeake City, Virginia, to a high of $12,633 for New York County, New York. Other Virginia jurisdictions--York County and James City--have low per capita incomes of $2360 and $2335. The Mid-Atlantic coastal region contributes significantly to national income and expenditure totals. However, there are considerable variations for counties within the region. Estimated unemployment rates and per capita income (1975) for Mid-Atlantic coastal counties are shown on Table II-139.

TABLE II-139.

Estimated Unemployment Rate and Per Capita Income

for Mid-Atlantic Coastal Counties

	1975 Estimated Civilian Unemployment Rate (Percent)	1975 Estimated Per Capita Income (Dollars)
United States	9.00	4511
Mid-Atlantic Coastal Region	8.78	5465
Delaware Coastal Region	7.49	5040
Delaware Coastal Counties		
Kent	10.44	3214
New Castle	6.82	5658
Sussex	8.94	4061
Maryland Coastal Region	7.71	4925
Maryland Coastal Counties		
Anne Arundel	7.95	4525
Baltimore	6.93	4497
Calvert	12.21	3657
Caroline	18.18	4701
Cecil	8.91	5519
Charles	10.32	5095
Dorchester	13.48	4253
Harford	10.17	6830
Kent	12.59	4947
Prince Georges	4.34	3980
Queen Annes	12.71	3843
St. Marys	10.54	4207
Somerset	22.58	3876
Talbot	11.09	4588
Wicomico	14.03	5046
Worcester	20.42	3831
Maryland Independent City		
Baltimore	8.45	5964

TABLE II-139 (Continued)

	1975 Estimated Civilian Unemployment Rate (Percent)	1975 Estimated Per Capita Income (Dollars)
New Jersey Coastal Region	9.49	5290
New Jersey Coastal Counties		
Atlantic	10.51	3956
Bergen	7.77	5963
Burlington	9.40	4179
Camden	7.64	4451
Cape May	18.82	3755
Cumberland	12.10	4451
Essex	11.60	5895
Gloucester	8.95	3582
Hudson	9.22	5409
Mercer	8.34	4933
Middlesex	10.14	5949
Monmouth	9.45	4183
Ocean	11.70	3158
Passaic	11.63	5517
Salem	9.62	5123
Somerset	12.22	4364
Union	6.74	7132
New York Coastal Region	8.67	5896
New York Coastal Counties		
Albany	7.58	5560
Bronx	11.06	4890
Columbia	9.48	4038
Dutchess	6.36	4873
Greene	13.47	4258
Kings	11.84	4635
Nassau	6.54	5540
New York	7.29	12633
Orange	9.19	4519
Putnam	12.67	3773
Queens	7.35	5784
Rensselaer	7.85	4156
Richmond	9.15	3776
Rockland	7.19	4040
Suffolk	7.94	3635
Ulster	10.75	4425
Westchester	6.82	5807

TABLE II-139.(Continued)

	1975 Estimated Civilian Unemployment Rate (Percent)	1975 Estimated Per Capita Income (Dollars)
Pennsylvania Coastal Region	9.61	5117
Pennsylvania Coastal Counties		
Bucks	7.04	3950
Delaware	7.62	4437
Philadelphia	10.64	5559
Virginia Coastal Region	6.65	4309
Virginia Coastal Counties		
Accomack	6.31	3477
Charles City	9.55	2766
Gloucester	5.67	3626
Isle of Wight	8.48	4064
James City	5.79	2335
Lancaster	7.01	3369
Mathews	7.36	3509
Middlesex	7.41	2592
Northampton	7.13	3590
Northumberland	5.54	2974
Prince George	4.96	3738
Surry	7.01	2696
Westmoreland	6.90	2889
York	9.08	2360
Virginia Coastal Independent Cities		
Chesapeake City	9.95	2152
Hampton City	9.71	3389
Hopewell City	3.30	4673
Newport News City	4.76	5700
Norfolk City	6.08	5980
Portsmouth City	7.16	5186
Suffolk City	9.52	3271
Virginia Beach City	7.40	3060
Williamsburg City	1.41	5843

Source: BLM New York OCS Office, Economic Study of the Possible Impacts of a Potential Baltimore Canyon Sale

Persons working in retail stores earned $20.3 billion, while those working in State and local governments earned $13.8 billion and those working in the finance, insurance, and real estate industries earned $10.0 billion. Persons working in these industries earn close to 35 percent of the total earnings of the area. The least amount of earnings as a percentage of total earnings are made by persons working in petroleum refining ($382.0 million), nonpetroleum mining ($89.2 million), water utility ($73.0 million), petroleum mining ($30.9 million) and forestry/fishery ($14.7 million) industries.

Auto dealers and service stations receive $4.2 billion from personal consumption expenditures. Electric and gas utilities receive $2.5 billion from personal consumption expenditures; $1.7 billion worth of refined petroleum products are purchased by consumers. The transportation sector receives $1.4 billion from personal consumption expenditures. These energy related expenditures total nearly $10 billion (8 percent of the region's total) and can be compared to the nearly $80 billion (66 percent of the region's total) received by the finance, insurance, real estate, agriculture, food, retail store, and medical and educational institution sectors.

Forty-four percent of the region's output can be attributed to the finance, insurance, real estate, retail store, and machine and other manufacturing sectors. The petroleum mining, nonpetroleum mining, forestry, and fishery sectors account for only 0.3 percent of the region's output.

Machinery, manufacturing, and agricultural goods account for greater than 47 percent of the region's imports. The petroleum mining and petroleum refining sectors import a significant amount of foreign competitive products even though they have only 8 percent and 5 percent, respectively, of the region's total imports. The petroleum mining sector imports $1.6 billion worth of pre-processed products, while the petroleum refining sector imports refined products from abroad worth $1.0 billion. These figures indicate that the region is significantly dependent on imports from abroad in these two domestically producing sectors.

The single greatest foreign export of the region is from the machines and miscellaneous manufacturing sector. Nearly $10.0 billion or 52 percent of the region's foreign exports consist of products from this sector. The second greatest foreign export of the region is from the chemicals and plastics sector. Nearly $2.1 billion or 11 percent of the region's foreign exports consist of products from this sector. These figures suggest that the region contains heavily industrialized areas. Such heavy industry exists near the port and refinery areas. Only 0.1 percent of the region's foreign exports come from the petroleum refining and petroleum mining sectors.

It can also be seen that the area exports significant amounts of products from the agriculture and food sectors. The area specializes in certain agriculture and food products while requiring the foreign import of other agriculture and food products for which no comparative advantage exists in the region. This discussion does not include

the Mid-Atlantic coastal region's exports and imports to other areas within the U.S. domestic economy which are quite extensive.

While the Mid-Atlantic coastal region contains 13.5 percent of the nation's population it is responsible for 16.8 percent of the nation's gross product. The difference between total supply and domestic output within the Mid-Atlantic region is due mainly to imports to the region. Total demand within the region is seen to be greater than the domestic output of the region, indicating that the region does not produce all goods and services needed, and imports to the region are required to meet total demand. An excess of total supply over total demand suggests that goods and services in the aggregate are available for export to other regions of the country. Foreign imports, for example, are handled at area ports for export out of the Mid-Atlantic coastal region to other areas of the country. Goods and services from such sectors as agriculture, food, chemicals, plastics, and machines and other manufacturing are also exported to other areas of the nation. Dollars flow into and out of the regional economy according to the nature and level of goods and services exported and imported.

Knowledge of the Mid-Atlantic region area and an examination of the data by industry allows us to draw the following conclusions:

(1). The area through production and trade is meeting its petroleum refining needs.

(2). The area has a need for petroleum mining products.

(3). A shortage still exists in the area for iron and steel products. A slight shortage exists for other metals.

(4). A considerable shortage of lumber and wood products can be found in the area.

(5). The nature of the region's output is such that exports and imports are required in the machines and other manufacturing sector while a shortage of supply remains in the area.

(6). Total supply in the agriculture and food sectors is not enough to meet the area's total demand. The nature of the production of the area is such that imports from outside the area are heavily depended upon to meet the demand existing in this sector.

(7). An excess of demand exists in the electric and gas utility sectors indicating a need for greater supply in the area.

(8). The construction sector is more than meeting the area demand for its services.

(9). A slight need for medical and educational services remains in the area.

(10). The area is a producer of chemicals and plastics and is able to export these products to outside areas.

(11). The retail store, wholesale trade, communication service, apparel, textile, auto dealer, service station, and amusement services sectors are all able to meet area demand requirements.

(12). A slight need for water utility services remains in the area.

(13). The data shows an excess of supply for the transportation sector. This sector's problem seems to be one of allocation.

While the above information describes the region as a whole, the Mid-Atlantic coastal region shows great diversity with regard to population density and economic activity and may be classified into several distinct kinds of areas:

I. Greater than 10,000 persons per square mile. Examples of counties meeting these characteristics include:

Baltimore City, Maryland
Hudson County, New Jersey
Kings County, New York
Philadelphia County, Pennsylvania

This class is representative of counties with the highest population densities.

IIa. 1001 to 10,000 persons per square mile. Less than 25 percent of output stemming from heavy industrial activities. Examples of counties meeting these characteristics include:

Prince Georges County, Maryland
Monmouth County, New Jersey
Nassau County, New York
Norfolk City, Virginia

This class is representative of counties with high population densities having limited heavy industrial activity.

IIb. 1001 to 10,000 persons per square mile. Greater than 25 percent of output stemming from heavy industrial activity. Examples of counties meeting these characteristics include:

Baltimore County, Maryland
Union County, New Jersey
Delaware County, Pennsylvania
Newport News City, Virginia

This class is representative of counties with high population density having an extensive heavy industrial base.

IIIa. 251 to 1000 persons per square mile in 1975. Less than 25 percent of output stemming from heavy industrial activity. Examples of counties meeting these characteristics include:

Harford County, Maryland
Atlantic County, New Jersey
Ocean County, New Jersey
Albany County, New York
Virginia Beach City, Virginia

This class is representative of counties which are of a more urban nature having limited heavy industrial activity.

IIIb. 251 to 1000 persons per square mile in 1975. Greater than 25 percent of output stemming from heavy industrial activity. Examples of counties meeting these characteristics include:

New Castle County, Delaware
Anne Arundel County, Maryland
Gloucester County, New Jersey
Bucks County, Pennsylvania
York County, Virginia

This class is representative of counties which are of a more urban nature having an extensive heavy industrial base.

IVa. 0 to 250 persons per square mile in 1975. Less than 15 percent of output stemming from heavy industrial activity. Examples of counties meeting these characteristics include:

Kent County, Delaware
Somerset County, Maryland
Cape May County, New Jersey
Accomack County, Virginia

This class is representative of counties with the lowest population densities and the most limited industrial bases.

IVb. 0 to 250 persons per square mile in 1975.

Greater than 15 percent of output stemming from heavy industrial activity. Examples of counties meeting these characteristics include:

Sussex County, Delaware
Kent County, Maryland
Salem County, New Jersey
Ulster County, New York
James City, Virginia

This class is representative of counties with the lowest population densities containing a more extensive heavy industrial base.

The following is a list of industries and activities existing in the Mid-Atlantic coastal region that are important to the region's economy in terms of linkage effects which are likely to be most affected should the proposed lease sale action be taken:

(1) Agriculture Production--Crops, Livestock, and Services.

(2) Fishing, Hunting, and Trapping.

(3) Mining and Quarrying of Nonmetallic Minerals Except Fuels.

Includes exploration, as well as development and mining or quarrying.

(4) Building Construction--General Contractors and Operative Builders.

Primarily engaged in construction of residential, farm, industrial, commercial, or other buildings.

(5) Construction other than Building Construction--General Contractors

Engaged in heavy construction such as highways, streets, irrigation and flood control projects, marine construction and other.

(6) Construction--Special Trade Contractors

Engaged in specialized activities such as plumbing, plastering or carpentry or primarily engaged in specialized activities including industrial machine and equipment installation, gas leak detection and water well drilling.

(7) Chemicals and Allied Products

Establishments primarily engaged in producing basic chemicals, and establishments manufacturing products by predominantly chemical process primarily produce three general classes of products in the Mid-Atlantic coastal region:

(a) Basic chemicals such as acids, alkalines, salts, and organic chemicals.

(b) Chemical products to be used in further manufacture such as synthetic fibers, plastics materials, dye colors and pigment.

(c) Finished chemical products to be used for ultimate consumption such as drugs, cosmetics, and soaps, or to be used as materials or supplies in other industries such as paints, fertilizers, and explosives.

Most of the activity in this industry occurs in those counties with a heavy industrial base (Type IIb, IIIb, and IVb).

(8) Petroleum Refining, Gas Processing, and Related Industries

Gas processing plants are not found in the Mid-Atlantic coastal region. Petroleum refining establishments found in the area are primarily engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, lubricants and other products from crude petroleum and its fractionation products, through straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking or other processes.

(9) Rubber and Miscellaneous Plastic Products

Manufacturing from natural, synthetic or reclaimed rubber. Those firms are located mostly near port and heavy industrial areas (Types I and IIb) and are often associated with chemical and petroleum industries (7 and 8 above).

(10) Primary Metal Industries

Establishments engaged in the smelting and refining of ferrous and nonferrous metals from ore, pig, or scrap; in the rolling, drawing, and alloying of ferrous and nonferrous metals; in the manufacture of nails, spikes, and insulated wire and cable; and in the production of coke. These firms are found extensively throughout the area (Mostly Type IIb, IIIb, and IVb).

(11) Machinery, Except Electrical

Establishments engaged in manufacturing machinery and equipment other than electrical and transportation equip-

ment. These firms are found throughout the area (Type I, IIb, IIIb, IVb).

(12) Transportation Equipment

Establishments engaged in manufacturing equipment for transportation of passengers and cargo by land, air, and water.

(13) Railroad Transportation

(14) Local and Suburban Transit and Interurban Highway Passenger Transportation.

(15) Water Transportation

(16) Transportation by Air

(17) Pipelines, Except Natural gas

(18) Electric, Gas and Sanitary Services

(19) Wholesale Trade

(20) Retail Trade

(21) Finance, Insurance and Real Estate

(22) Public Administration

This division includes the legislative, julicial, administrative and regulatory function of all levels of government.

Other industries found in the area that can expect to experience minimal impacts mostly stemming from shifting population and the resulting changes in demand include the following:

Food and Kindred Products

Apparel and other finished products made from fabrics and similar materials

Furniture and Fixtures

Lumber and Wood Products except Furniture

Paper and Allied Products

Printing, Publishing and Allied Industries

Leather and Leather Products

Stone, Clay, Glass, and Concrete Products

Fabricated Metal Products except Machinery and Transportation Equipment

Electrical and Electronic Machinery, Equipment and Supplies

Measuring, Analyzing, and Controlling Instruments, Photographic, Medical, and Optical Goods, Watches and Clocks

Miscellaneous Manufacturing Industries

Motor Freight Transportation and Warehousing

Communication

Services

3. Previous History of Some Major Oil Spills in the Region[1]

Oil spills, even massive oil spills, are not an unknown phenomena in the Mid-Atlantic coastal region. Claims that the area has not experienced them have to be tempered with what is known from the history of tanker accidents and sinkings particularly during World War II. Reports of coastal impact are not readily available for the war period because national defense measures included the censoring of newspaper articles which might have confirmed tanker sinkings by submarines. However, the following information has been assembled from diverse sources.

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[1] This section does not attempt to include all spills in the region due to inadequate historic records or reporting discrepancies.

Figure II-95 shows the location of tanker sinkings and accidents in the subject area between 1940 and 1972: thirteen tankers[1] carrying oil were sunk during the war according to Lloyds of London information. Coast Guard war records (1945) show an additional four sinkings of tankers though there is no indication of how much, if any, oil cargo was contained. Six tankers sunk in the region between 1945 and 1972. Using a load factor of 12.5 barrels of petroleum per gross ton of ship registry (Bybee, 1971), 1,151,512 barrels of oil were spilled from tankers (minimum estimate) from 1942 to 1945 and 1,591,775 barrels between 1942 and 1972. The figure does not indicate the large number of ships which were torpedoed during the war and leaked fuel supplies into the marine environment.

Large amounts of oil did come ashore, especially along the New Jersey coast, as shown in Life Magazine articles[2]. The extensive coverings were basically unremoved, except for isolated bathing beaches, during the war years (New Jersey Coast was fortified at the time). Personal accounts indicate that all beaches were cleaned and mostly free of tar by 1948, either by natural action

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[1]A Return Compiled from Lloyds Records Showing Tankers Which Were Lost Within 100 miles of the East Coast of the United States of America (Maine to Florida) from January, 1940 to February, 1972. Provided to H. Bybee, Continental Oil Co., Houston, Texas, written communication, 1975.

[2]Life Magazine, May 29, 1942, p28-29; July 6, 1942, p24-25.

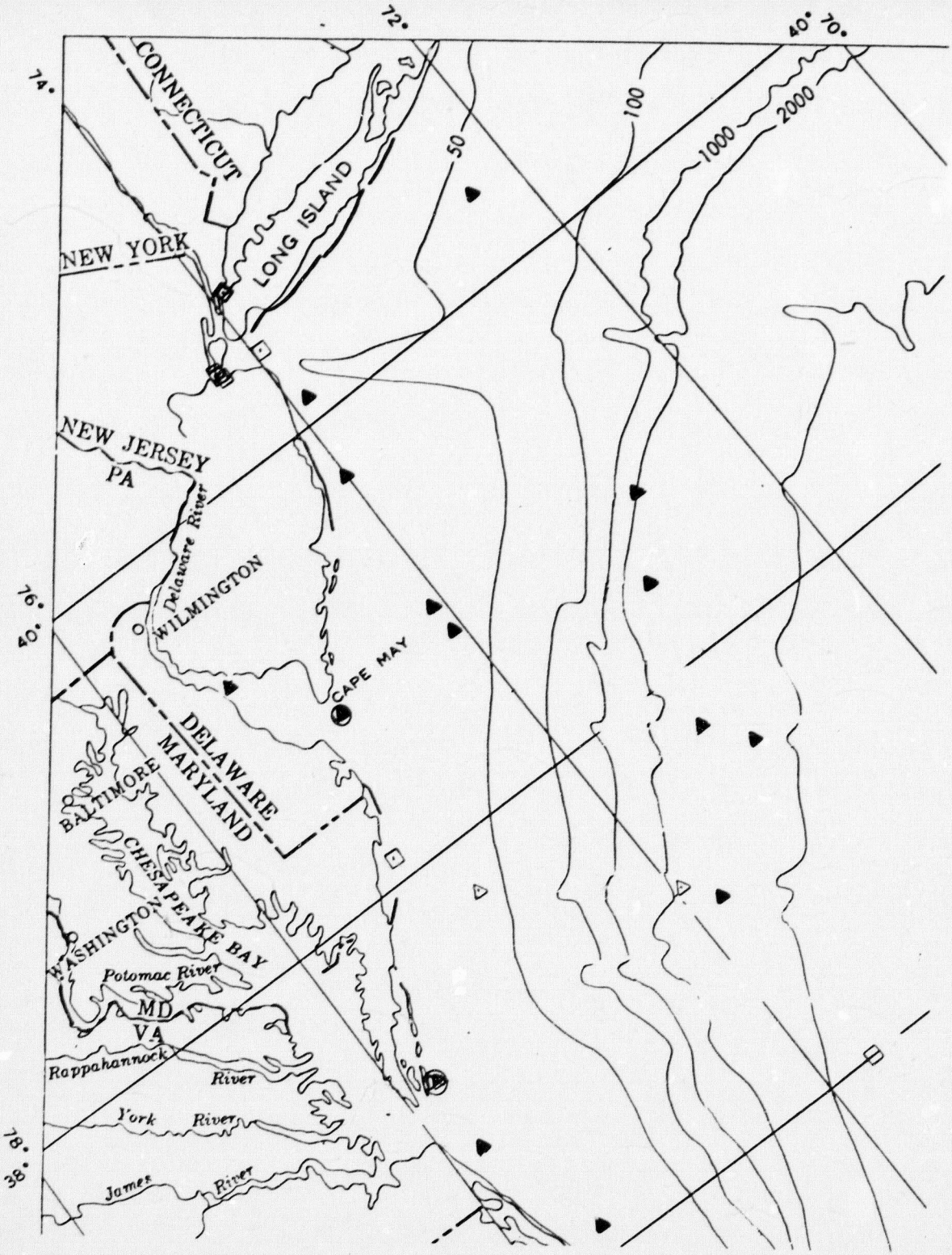

FIGURE II-95. Mid-Atlantic tanker sinkings 1940-1972.
▲ - WW II tanker sinking/oil cargo, △ - WW II tanker sinking/ cargo uncertain, ⊡ - post-1945 tanker sinking, ◯ - tanker towed and salvaged.

(weathering, wave action) or cleanup operations. There have been no efforts to determine the long-term effects of these spills. It can be assumed that on outward appearances only, tourism and the coastal habitats recovered in a relatively short period considering the amounts of oil spilled.

H. Future Environment Without the Proposal

Without the proposed lease sale in the Baltimore Canyon, the Mid-Atlantic region can be expected to experience continued economic growth. Population growth should continue over time with the region becoming more densely populated with a greater number of areas supporting this increased population. In general, population trends which began in the 1950's and continued in the 1960's should continue, but at a slower pace.

The number of civilian persons employed can be expected to grow over time with per capita income increasing, which suggests that the area's economy will be expanding. Other indicators, such as expanding consumption, investment, regional production, and population migration into the area, verify this conclusion. Relative to the value of total output within the Mid-Atlantic coastal region, the percentage of the value of production within the chemicals and plastics, machines and miscellaneous manufacturing, transportation, wholesale trade, and retail stores sectors of the economy can be expected to grow. The percentage of the value of production within the agriculture, food, finance, insurance, real estate, amusement, and services sectors can be expected to decline. Demand within the region can be expected to grow proportionately faster and eventually become greater than supply, suggesting that the area will experience economic conditions of excess supply in the immediate years and then over time become an area with excess demand.

With increased population and economic activity, there will be continued pressures on available land for development. While in the region as a whole, a large amount of undeveloped land suitable for residential, commercial and industrial uses exists, the strongest development pressures will probably take place in areas where such pressures are already the greatest or are presently increasing. Competition for available land--between developed uses and agriculture, open space and preservation--will continue. Efforts are currently underway, on a national level, as well as at state and local levels in the Mid-Atlantic region, to achieve a balanced use of land resources. Wetlands legislation, proposed energy facility siting laws, coastal zone management efforts and regional and local planning efforts are all examples of attempts to accomodate necessary activities with the least environmental damage and the greatest enhancement of the human environment. The extent to which these competing land uses will be balanced will continue to depend on the effectiveness of regulatory and planning efforts at all levels of government.

The development and destruction of coastal areas in recent years have decreased habitats for certain wildlife forms to the point at which their status has been jeopardized. If the destruction of the coastal habitats should continue, the decline of many species dependent on this habitat can also be expected to occur. Continued development in other areas could also affect upland species. To the extent that wildlife habitats are destroyed by future development,

decreases in the populations of upland species would also occur.

Recreation demand in each of the five Mid-Atlantic states is projected to increase markedly during the next two decades, and it has been predicted that significant portions of this increase will take place in the coastal states. Much of this demand may take place in the form of day and weekend use as opposed to vaction/destination use, as the relative significance of the latter has been declining for the past two decades. This decline has resulted in a net outflow of vacation days from the Mid-Atlantic states to other regions of the country. This declining trend may not continue, however, based on recent recreation/tourism patterns. The 1973-1974 oil embargo and its effects altered these patterns during the 1974 summer season. As a consequence, the New Jersey shore resort areas experienced one of their best seasons ever. It is too early to determine whether this trend will continue in the long-term. However, if Americans are forced, because of high energy costs and other economic factors, to allot proportionately decreasing amounts of expenditures to recreational pursuits, and if leisure time remains the same or increases, much of the recreation and tourism demand could be met closer to home. The Mid-Atlantic States would be major beneficiaries of this demand. However, provisions to meet recreation demand, particularly demand for day-use facilities, will continue to face competitive from other land uses and fund allocations.

Even with increased economic activity in the region, prospects for

overall decreases in pollution levels are good. Time limits have been set by Congress for controlling point sources of air and water pollution. Although these dates are thought by some to be unreasonable or impossible and may soon be changed, a national commitment has been made. The present standards and guidelines that have been developed and the monies set aside should insure that the positive trends observed in recent years will continue. As the development of more sophisticated technologies for controlling industrial processes and municipal and industrial effluents continues, water quality of the rivers and bays in the region should improve. The quality of the air should also continue to improve with better technologies applied to stationary and mobile sources. Better fuel economy in automobiles and conservation efforts in the private, municipal and industrial sectors would decrease the levels of air pollutants. However, if the use of high sulfur coal were to increase in the region because of the lack of fuel oil, this trend could be reversed if concomitant controls are not developed and utilized. Solid waste recovery systems that produce valuable materials and provide additional energy sources should become more prevalent. Better controls on landfill practices and incinerators will reduce pollution from these sources. Reduction should also occur in point sources of noise and radiation pollution. However, the remaining problems of nonpoint and complex sources of pollution and the synergistic effects of pollutants will remain problems for a longer period of time. These problems sometimes account for a greater percentage of pollution than the point sources.

With regard to marine resources, conflicting trends will continue. The development of more sophisticated technologies for controlling industrial and municipal effluents should aid in attainment of better offshore water quality. It is proposed that ocean dumping be minimized or discontinued as soon as better methods are developed for the disposal of sewage sludge and toxic and hazardous wastes. However, until these methods are developed, the ocean floor will continue to be used as a depository for waste materials. Tankers and barges would remain major sources of oil pollution as foreign oil imports would continue to meet domestic demand. However, new regulations for United States tankships and barges engaged in domestic trade should decrease the amount of oil discharged into the ocean by these vessels. The extension of these regulations to other vessels would result in further decreases of oil pollution. Demand for sand and gravel, for which onshore supplies are rapidly being depleted, may eventually result in ocean mining efforts both on state and Federal submerged lands. This activity would affect the seafloor, altering the substrate and causing turbidity. Benthic organisms, as well as light-dependent organisms would be impacted.

It is anticipated that commercial harvest efforts directed as fish and shellfish will increase in the years to come. The success of these efforts is doubtful, however, without good management practices. Stocks of many species have declined in recent years due to over-fishing and habitat destruction by either physical means or by the various forms of pollution. Fishing efforts for underutilized

species can be expected to increase stocks of presently utilized ones decrease. Stocks of all species, however, are exhaustible without good management practices. The recent enactment of the Marine Fisheries Conservation Act of 1976 (P.L. 94-264) should eventually lead to better management and thus a more sustained yield.

It is possible that without proposed OCS Sale #40, pressure to provide new sources of gas and oil may lead to leasing efforts in State waters. It is thought that updip wedgeouts of Jurassic and Cretaceous strata may occur within the three-mile jurisdiction of the Mid-Atlantic states (especially New Jersey, Delaware and Maryland).[1] If petroleum is present in the Baltimore Canyon Trough it could have migrated up to stratigraphic traps in state waters. Although several hundred wells have been drilled on state lands without oil and gas finds, exploration has not been directed at these difficult to locate traps. State production would result in many of the same impacts as discussed in this impact statement; however, because the state production would be closer to shore, greater dangers to coastal areas due to oil pollution could be expected.

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[1] U.S.Geological Survey

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